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INTERNATIONAL RESERVES MANAGEMENT AND THE CURRENT ACCOUNT

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ABSTRACT

The paper assesses the costs and benefits of active international reserve management (IRM), shedding light on the question of how intense should IRM be for an emerging market. In principle, an active IRM strategy could lower real exchange rate volatility induced by terms of trade shocks; provide self insurance against sudden stops; reduce the speed of adjustment of the current account; and even allow for higher growth if it fosters exports ("mercantilist" motive). The message of the report is mixed -- management of reserves is not a panacea. The mercantilist case for hoarding international reserves, as an ingredient of an export led growth strategy, is dubious. Done properly, IRM augments macro economic management in turbulent times, mitigating the impact of external adverse shocks and allowing for a smoother current account adjustment. These benefits are especially important for commodity exporting countries, and countries with limited financial development.

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> "Several factors, apart from the exchange rate regime, influence the comfort level in regard to reserves. Illustratively, they would include vulnerability to the real sector shocks, strength of the fiscal and financial sectors, current account balance, the changing composition of capital flows, a medium-term view of growth prospects encompassing business cycles, etc. In a sense, official reserves have to reflect the balancing and comforting factors relative to external assets and liabilities in the context of a rational balance sheet approach."
>
> *Dr. YV Reddy, Governor, Reserve Bank of India / Mumbai Sep 20, 2006*

> "…following the Asian crisis of the late 1990s it was likely that countries might choose to build up large foreign exchange reserves in order to be able to act as a "do it yourself" lender of last resort in US dollars."
>
> *A speech by Mervyn King, Governor of The Bank of England, New Delhi, 20 February 2006*

This paper assesses the costs and benefits of active international reserve management (IRM). The first part outlines and appraises various channels where IRM may enhance economic performance, focusing on two important channels: i) IRM lowers real exchange rate volatility induced by terms of trade shocks; ii) IRM provides self insurance against sudden stops and fiscal shocks, reducing the downside risk associated with adverse shocks. There is weaker evidence regarding other channels, including iii) A mercantilist motive, where IRM is alleged to lead to higher growth induced by fostering export; and iv) A greater capacity to smooth overtime adjustment to shocks, thereby reducing the speed of adjustment of the current account.

Our analysis of international reserve management supplements the insights of earlier literature, which focused on using international reserves as a buffer stock, as part of the management of an adjustable-peg or managed-floating exchange-rate regime.[1] While valid, the buffer stock approach fitted better a world with limited financial integration, where trade openness determined countries' vulnerabilities to external

[1] Accordingly, optimal reserves balance the macroeconomic adjustment costs incurred in the absence of reserves with the opportunity cost of holding reserves (see Frenkel and Jovanovic, 1981). The buffer stock model predicts that average reserves depend negatively on adjustment costs, on the opportunity cost of reserves, and on exchange rate flexibility; and positively on GDP and on reserve volatility driven frequently by the underlying volatility of international trade. Overall, the literature of the 1980s supported these predictions; see Frenkel (1983), Edwards (1983), and Flood and Marion (2002) for a recent review.

shocks. In the absence of reserves, balance of payments deficits would have to be corrected via a reduction in aggregate expenditures, imposing adjustment costs. As greater trade openness increases the exposure to trade shocks, minimizing adjustment costs requires higher reserve holdings. The rapid financial integration of developing countries, and the financial crises of the 1990s focused attention on the growing exposure to sudden stops and on reversals in flows of capital.[2] In such a world, financial markets may force an adjustment well before flows of commercial trade would adjust, shifting the focus to exposure to financial shocks, and to costs associated with disintermediations triggered by adverse liquidity shocks.

Section 1 evaluates empirically the impact of international reserves on real exchange rate volatility in the presence of terms of trade shocks. The evidence suggests that international reserves play a role in the mitigation of terms of trade (TOT) shocks in Developing countries, but not in the OECD. Economic structure matters greatly – exports of natural resources double both the impact of terms of trade shocks on the real exchange rate, and that of the mitigation associated with IRM on the real exchange rate. These results are consistent with the notion that the limited development of capital markets in developing countries hampers their ability to mitigate the volatility associated with shocks. Section 2 models such a mechanism, explaining possible effects of IRM in the presence of costly financial intermediation of long term investment. Section 3 overviews the debate about international reserves management and mercantilist motives, outlining the empirical and the theoretical limitations of the mercantilist approach. The mercantilist case for hoarding international reserves, as an ingredient of an export led growth strategy, is lacking empirical evidence. In addition, hoarding international reserves motivated by short-run competitiveness concerns of one country may trigger other countries into adopting a similar policy, to preempt any competitive advantage gained by the first country. These circumstances may lead to competitive hoarding of reserves, which in turn would dissipate any competitiveness gains. Section 4 evaluates the impact of international reserves on current account persistence. The results support the notion that a higher build up of reserves allows countries to be better buffered against

[2] See Calvo (1998), Calvo et. al. (2003) and Edwards (2004), and the references therein for assessment of sudden stops in developing countries.

shocks, thereby reducing the speed of adjustment of the current account. This outcome is consistent with the importance of current account adjustments in allowing for smoother consumption, in the presence of limited financial integration and sudden stops. Section 5 concludes with a discussion of the limitations of international reserves management.

1. **Real exchange rate volatility, terms of trade and international reserves.**

In this section we focus on some of the challenges facing a developing country with limited development of its internal capital market, a growing integration with the global financial system, and a large exposure of the current account to terms of trade effects. This description applies especially to commodity exporting countries, subject to large terms of trade shocks. While favorable terms of trade shocks tend to induce real appreciation and capital inflows, the downturns associated with adverse shocks impose daunting challenges. To put this topic in a broader context, note that the literature of the 1990s identified large adverse effects of exogenous volatility on the GDP and on economic growth in developing countries.[3] Fundamentally, this issue hinges on the nature of non-linearties affecting the economy, where strong enough concavity may generate first order adverse effects of volatility on the GDP and on growth. An important channel that may explain such negative level and growth effects of volatility are imperfect capital markets.

A recent contribution illustrating these considerations is Aghion, Bacchetta, Ranciere and Rogoff (2006), who found that real exchange rate volatility reduces growth for countries with relatively low levels of financial development. These studies suggest that factors mitigating real exchange rate volatility may be associated with superior economic performance. The large hoarding of international reserves by developing countries in recent years raises the question to what extent have these reserves affected the volatility of the REER. For most countries, terms of trade shocks are the most important source of exogenous volatility, frequently leading to real exchange rate

[3] See Ramey and Ramey (1995) and the references in Aizenman and Pinto for the association between macro volatility and growth. See IDB (1995) and Calderón and Schmidt-Hebbel (2003) for the impact of terms of trade shocks and of other foreign shocks on growth in Latin America and in developing countries.

volatility, potentially magnifying business cycle volatility. This issue is pertinent for developing countries, as they are exposed to TOT volatility, the standard deviation of which is 3 times the volatility of industrial countries. Shallow domestic financial systems of relatively small size, and the lack of sectoral diversification in most developing countries limit their ability to mitigate TOT shocks by internal adjustment. Sovereign risk and the lack of proper financial instruments inhibit the ability to hedge against these shocks by relying on the global financial system [see Caballero (2003) and Caballero and Panageas (2003)]. Developing countries may be left with self insurance as a last resort option for dealing with TOT shocks.

In Aizenman and Riera-Crichton (2006) we confirm this possibility. We start by applying a rudimentary panel regression methodology, and show that the main result is robust to adding controls and to a more sophisticated estimation method. Specifically, the benchmark regression is

$$(1) \qquad \ln(REER_{it}) = a_{1,i} + \alpha_1 (TO * \ln(TOT))_{it} + \alpha_2 (TO * \ln(TOT) * RES)_{it} + \varepsilon_{it}$$

where the independent variable is the log of the real effective exchange rate (REER), defined so that a higher REER indicates real appreciation. The term $a_{1,i}$ represents country fixed effects, TOT is the terms of trade, $TO = \ln[1 + (\frac{IM + EXP}{2GDP})]$ is the trade openness measure, and $\text{RES} = \ln[1 + \frac{\text{International Reserves}}{\text{GDP}}]$ is a proxy for the International reserves/GDP.

The specification of regression (1) follows the observation that $TO * \widehat{TOT}$ is a first order approximation of the income effect associated with terms of trade improvement rate of $\widehat{TOT}$, where the income effect is defined as the GDP rate of change induced by a TOT shock. Henceforth I refer to $TO * \widehat{TOT}$ as the effective terms of trade shock. By design,

(1) implies that the elasticity of the real exchange rate with respect to effective terms of trade change is[4]

$$(2) \qquad \frac{\partial \ln(REER)}{TO * \partial \ln(TOT)} = \alpha_1 + \alpha_2 * RES$$

Hence, regression (1) provides information about the degree to which hoarding international reserves may impact REER dynamics induced by terms of trade shocks. Table 1 reports the regression results for 1970-2004. Column (1) presents the baseline regression pooling all countries, subject to data availability. The elasticity of the REER with respect to the effective terms of trade shock is well above one: a one percent improvement of the effective terms of trade induces a REER appreciation of about 1.8 percent. International reserves hoarding lessens the elasticity of the REER with respect to the TOT by more than twice the International reserves/GDP (i.e., column (1) implies that $\partial \ln(REER) / [TO * \partial \ln(TOT)] \cong 1.8[1 - 2 * RES]$).

Equation (2) is the elasticity of the REER with respect to the *effective* TOT, implying that the elasticity of the REER exchange rate with respect to the TOT is $\partial \ln(REER) / \partial \ln(TOT) = TO * [\alpha_1 - \alpha_2 * RES] \cong TO * 1.8[1 - 2 * RES]$. Hence, for a country with trade openness of 0.25, and IR/GDP ratio of 0.1, the elasticity of the REER with respect to the TOT is .25*1.8(1-2*0.1) = 0.36, in line with De Gregorio and Wolf (1994), who found that the elasticity of the REER with respect to TOT, unconditional of the RES position, is about 0.4.

Aggregation matters -- columns (2) and (3) show that this result applies to developing, but not to Industrial countries. This is consistent with the notion that limited development of the capital market in developing countries hampers their ability to mitigate the volatility associated with shocks. Economic structure matters greatly – exports of natural resources magnify the impact of the effective terms of trade shocks and the mitigation associated with international reserves by a factor exceeding 2. Interestingly, the international reserve effect is insignificant for that group, yet we will

[4] Throughout our discussion we presume that trade openness and International reserves/GDP are characterized by low volatility relative to *TOT* volatility.

show later that it's significant for the lagged TOT shock. In contrast, these interactions are insignificant for manufacturing intense countries. The last two columns focus specifically on Latin America and Asia; TOT shocks induce large effects in both blocks. International reserves induce a powerful mitigation of the TOT shock in Asian countries, but not in LATAM.

Table 2 verifies the robustness of prior results, redoing the base regression of the case where we evaluate the adjustment to the one year lagged terms of trade shock on the contemporaneous REER:[5]

$$(1') \qquad \ln(REER_{it}) = a_{1,i} + \alpha_1(TO * \ln(TOT))_{it-1} + \alpha_2(TO * \ln(TOT) * RES)_{it-1} + \varepsilon_{it}$$

The signs are identical to Table 1, the main difference being that shocks are apparently absorbed faster in LATAM and Asia, where most of the coefficients on the lagged shocks are insignificant for these blocks.

Table 3 reports country specific results for several Latin American countries. The last two columns of the Individual country table represent the total effect of terms of trade changes (amplified by trade openness) into the real exchange rate; taking into account the mitigation offered by international reserves:

$$(3) \qquad \text{Total Effect 1990-99} = \frac{\partial \ln(REER)}{\partial[TO * \ln(TOT)]} = \left[\alpha_1 + (\alpha_2 * RES_{1990-99})\right],$$

$$(4) \qquad \text{Total Effect 2000-04} = \frac{\partial \ln(REER)}{\partial[TO * \ln(TOT)]} = \left[\alpha_1 + (\alpha_2 * RES_{2000-04})\right]$$

Overall, the results suggest that reserves play a role in the mitigation of TOT shocks only in Developing countries. While this role widely differ across countries, the mitigation role of international reserves is important, especially in countries abundant with natural resources, like Argentina, Chile, Ecuador and Mexico.

[5] We rejected the unit root hypothesis for the REER. We applied a Levin-Lin-Chu panel unit root test. The test assumes that each individual unit in the panel shares the same AR(1) coefficient, but allows for individual effects, time effects and possibly a time trend. We found high persistence: the autoregressive coefficient of about 0.84, but well below 1.

The results reported above focus on the association between the level of the terms of trade, International reserves/GDP and the real exchange rate. We also verified that a higher International reserves/GDP is associated with a lower REER volatility. This result is consistent with Hviding, Nowak and Ricci (2004), who focused on the association of International reserves/GDP and the volatility of the real exchange rate, controlling for exchange rate regimes. Aizenman and Riera-Crichton (2006) also confirmed that the mitigation effects identified in (2) continue to hold when we control for exchange rate regimes, and for the composition of capital flows [see Broda and Tille (2003) for the role of exchange rate flexibility in accommodating the adjustment to terms of trade shocks].

Appendix A outlines a case study of Chile. Applying OLS and a VAR analysis, we find that an improvement in Chile's terms of trade is associated with a drop of the lending and deposit rates, and an improvement of Chile's external risk evaluation. We turn now to an elaborate model of costly financial intermediation, explaining possible self insurance aspects of ex-ante hoarding of international reserves.

2. **The model -- financial intermediation, self insurance and the real exchange rate**

A growing literature has identified financial intermediation, in the presence of collateral constraints, as a mechanism explaining the hazard associated with credit cycles induces by shocks. The prominent role of bank financing in developing countries suggests that capital flights, induced by adverse terms of trade shocks or contagion, impose adverse liquidity shocks. This section outlines a model describing conditions under which ex-ante hoarding of international reserves may provide a self insurance mechanism that would mitigate the real effects of liquidity shocks, ultimately reducing the adverse effects of terms of trade volatility on the GDP. For simplicity, we focus on an ex-ante/ex post model dealing with the determination of the GDP level and the real exchange rate during one investment cycle. Applying the logic of endogenous growth, one may extend the model to deal with the impact of terms of trade shocks on growth.

As our focus is on developing countries, we assume that all financial intermediation is done by banks, relying on debt contracts. Specifically, we consider the

case where investment in a long-term project should be undertaken prior to the realization of liquidity shocks. Hence, shocks may force costly liquidation of earlier investments, thereby reducing output. We solve the optimal demand for deposits and international reserves by a bank that finances investment in long-term projects. The bank's financing is done using callable deposits, exposing the bank to liquidity risk. Macro liquidity shocks, stemming from sudden stops and capital flights, cannot be diversified away. In these circumstances, hoarding reserves saves liquidation costs, potentially leading to large welfare gains; gains that hold even if all agents are risk neutral. In this framework, deposits and reserves tend to be complements – higher volatility of liquidity shocks will increase both the demand for reserves and deposits. This is another example of hoarding international reserves as a self-insurance against non-diversifiable liquidity shocks.[6]

We model the financial intermediation and the real exchange rate by combining Diamond and Dybvig's (1995) insight with Aghion, Bacchetta and Banerjee's (2003) modeling of market imperfections in a collateral dependent small open economy.[7] We construct a minimal model to explain the self insurance offered by international reserves, in mitigating the output effects of liquidity shocks with endogenous real exchange rate determination. Investment in a long term project should be undertaken prior to the realization of liquidity shocks. Hence, the liquidity shock may force costly liquidation of the earlier investment, reducing second period output. We simplify further by assuming that there is no separation between the bank and the entrepreneur – the entrepreneur is the bank owner, using it to finance the investment.

We consider a small open economy, where a traded good is produced with capital and a country specific non-traded factor. In addition, the traded sector includes exports of commodities, generating revenue which is determined by the realization of terms of trade shocks [= the relative price of the exported commodities to other traded goods]. The traded good is the numeraire. The relative price of the non-traded factor is denoted by *p*,

[6] See Ben-Bassat and Gottlieb (1992), Aizenman and Marion (2003), Garcia and Soto (2004), Aizenman and Lee (2005), Jeanne and Ranciere (2005), and Rodrik (2006) for studies dealing with various aspects of self insurance and international reserves.

[7] The model extends the one sector framework outlined in Aizenman and Lee (2005).

and is referred to as the real exchange rate There is a continuum of lenders and borrowers and their number is normalized to 1.

We focus now of the evolution of the economy throughout one investment cycle, where gestation lags imply that capital should be installed well before hiring specific non-traded input. To simplify, the supply of the specific factor is inelastic, at a level *Z*. The lenders in the economy cannot invest directly, but lend their saving at the international interest rate. Depositors are entitled to a real return of r_f on the loan that remains deposited for the duration of investment. The safe return reflects a risk free investment opportunity, either in the form of a foreign bond, or as storage technology. The borrowers are entrepreneurs who have investment opportunity, but are credit constrained. The actual investment should be undertaken prior to the realization of liquidity shocks. The production function is a Cobb Douglas CRS technology:

$$(5) \qquad y_2 = \frac{1}{a}\bar{\bar{K}}_1^{\beta} z^{1-\beta},$$

where $\bar{\bar{K}}_1$ is the non-liquidated capital invested at period 1, z is the level of country-specific input, hired at a relative price of p_1. Premature liquidation of capital is costly, and is associated with a proportionate adjustment cost of θ. Specifically, reducing the capital stock by one dollar yields a net liquidity of $1/(1+\theta)$.

The time line associated with financial intermediation is summarized in Figure 1. At the beginning of period 1, the entrepreneur with initial wealth H_1, borrows μH_1.[8] The combined liquidity of $(1+\mu)H_1$ finances planned investment K_1, and setting aside liquid reserves R_1:

$$(6) \qquad (1+\mu)H_1 = K_1 + R_1.$$

[8] Collateral constraints can be shown to arise due to capital market imperfections in the presence of moral hazard and costly monitoring [see Holmstrom and Tirole (1996) and Aghion, Banerjee and Piketty (1999)].

Next, a liquidity shock δ realizes. A positive shock is inconsequential, because banks can accommodate positive liquidity shocks by purchasing a risk free bond, or investing in the risk free low yield storage technology. Hence, we focus our attention on adverse liquidity shocks, reducing desirable deposits form μH_1 to $\mu H_1(1+l\delta)$, $\delta < 0, l > 0$. Our model focuses on the impact of adverse liquidity shocks on optimal investment and liquidity, refraining from modeling the reasons for the shock. Such a shock may reflect external developments, like a higher foreign interest rate, contagion, or a reaction to a signal revealing the future TOT. For example, suppose that the public learns of a signal δ, determining the second period foreign currency earnings from commodity exports. A negative TOT shock may induce anticipation of an economic slowdown, triggering capital flights, and reducing deposits from μH_1 to $\mu H_1(1+l\delta)$. Independently of the exact source of the adverse liquidity shock, gestation lags associated with tangible investment and costly liquidation, expose the bank to the downside risk associated with abrupt adjustment.

The bank uses reserves to meet the liquid shock and to purchase the non-traded input. In case of need, the liquidly shock may be met by costly liquidation of capital. Consequently, the ultimate capital is:

$$(7) \qquad \bar{K}_1 = \begin{cases} K_1 - (1+\theta)MAX\left\{(-\delta)l\mu H_1 + p_1 z - R_1,\ 0\right\} & if \quad \delta < 0 \\ \\ K_1 \quad if \quad \delta \geq 0 \end{cases} .$$

We assume that the liquidity constraint is binding, and that the marginal productivity of the non traded input exceeds the return on liquid reserves. The producer's surplus is

(8)

$$\Pi = \begin{cases} \frac{1}{a} K_1^{\beta} \left[\frac{(1+\mu)H_1 - K_1}{p_1} \right]^{1-\beta} - (1+r_f)\mu H_1 & if \quad \delta \geq 0 \\ \frac{1}{a} \bar{K}_1^{\beta} \left[\frac{\{1+\mu(1+l\delta)\}H_1 - K_1 + (K_1 - \bar{K}_1)/(1+\theta)}{p_1} \right]^{1-\beta} - (1+r_f)\mu H_1(1+l\delta) & if \quad \delta < 0 \end{cases}$$

,

where p_1 may depend on δ.

To gain further insight, it is useful to focus on the simplest discrete example, where with probability half an adverse liquidity shock of $\delta = -\varepsilon$ $(0 \leq \varepsilon < 1)$ would take place, and with probability half there would be no liquidity interruption. The value of ε corresponds to the volatility of the liquidity shock, δ. The asymmetric nature of tangible investment implies that only negative liquidity shocks may require real adjustment. In these circumstances, the expected profits are:

(9)

$$E[\Pi] = 0.5 \begin{cases} \frac{1}{a} K_1^{\beta} \left[\frac{(1+\mu)H_1 - K_1}{p_1} \right]^{1-\beta} \\ -(1+r_f)\mu H_1 \end{cases} + 0.5 \begin{cases} \frac{1}{a} \bar{K}_1^{\beta} \left[\frac{\{1+\mu(1-l\varepsilon)\}H_1 - K_1 + (K_1 - \bar{K}_1)/(1+\theta)}{p_1} \right]^{1-\beta} \\ -(1+r_f)\mu H_1(1-l\varepsilon) \end{cases}$$

,

where $K_1 \geq \bar{K}_1$

Applying the above, the equilibrium is characterized by the following:

Claim:

I. If no liquidation would take place in the bad state ($K_1 = \bar{K}_1$), optimal planned capital (K_1) is the solution to

(10a) $$\frac{\beta}{K_1} - \frac{1-\beta}{(1+\mu)H_1 - K_1} + \left[\frac{\beta}{K_1} - \frac{1-\beta}{[1+\mu(1-\varepsilon l)]H_1 - K_1} \right] = 0$$

If liquidation would occur in the bad state ($K_1 > \bar{K}_1$), the optimal planned capital (K_1) is determined by

(10b)

$$\left[\frac{K_1}{\bar{K}_1}\right]^{\beta}\left[\frac{\beta}{K_1}-\frac{1-\beta}{(1+\mu)H_1-K_1}\right]-\theta\left[\frac{\beta^2}{\bar{K}_1}+\frac{(1-\beta)^2}{[1+\mu(1-\varepsilon l)]H_1(1+\theta)-\theta K_1-\bar{K}_1}\right]=0;$$

where

$$\bar{K}_1=\beta\left[(1+\mu(1-\varepsilon l)H_1(1+\theta)-\theta K_1\right]. \tag{11}$$

II. The threshold volatility associated with partial liquidation in bad times, denoted by $\tilde{\varepsilon}$, is

$$\tilde{\varepsilon}=(1+\frac{1}{\mu})\frac{2\theta}{1+\theta}\frac{1-\beta}{l(1-\theta\beta)}. \tag{12}$$

Hence, small enough leverage and a large enough adjustment cost implies $\tilde{\varepsilon}>1$ -- the liquidation option would not be exercised. In these circumstances, the optimal investment and the ex-ante hoarding of international reserves are:

$$\begin{aligned} K_1&=\beta(1+\mu)H_1-0.5\beta l\varepsilon\mu H_1;\\ R_1&=(1-\beta)(1+\mu)H_1+0.5\beta l\varepsilon\mu H_1 \end{aligned} \quad . \tag{13}$$

The adjustment to the adverse liquidity shock is facilitated by real exchange rate depreciation:

$$p_{1|\delta=-\varepsilon}=\frac{(1-\beta)(1+\mu)H_1-\varepsilon(1-0.5)\beta l\mu H_1}{Z};\quad p_{1|\delta=0}=\frac{(1-\beta)(1+\mu)H_1+0.5\varepsilon\beta l\mu H_1}{Z}. \tag{14}$$

III. If $\tilde{\varepsilon}<1$, the partial liquidation option would be exercised in bad times only if the volatility exceeds the threshold, $\tilde{\varepsilon}<\varepsilon<1$. For volatility below the threshold, $\varepsilon<\tilde{\varepsilon}<1$, no liquidation would take place, and the equilibrium is characterized by (13)-(14).

Proof:

- The characterization of the planned investment and of the ex-ante hoarding of reserves, (13), follows by solving K_1 from (10a).
- The optimal stock of capital following partial liquidation, (11), is obtained by maximizing the profits in bad times with respect to $\overline{K}_1$ [the second line of (8)], noting that K_1 has been preset at the beginning of the planning horizon.
- The volatility threshold inducing liquidation in bad times, $\tilde{\varepsilon}$, is obtained by noting that at $\varepsilon = \tilde{\varepsilon}$, $K_1 = \overline{K}_1$ -- at the lowest volatility associated with liquidation in bad times, the liquidation is zero. Solving (11) for the case where $K_1 = \overline{K}_1$, we infer that $\overline{K}_1|_{\varepsilon=\tilde{\varepsilon}} = \frac{\beta(1+\theta)}{1+\beta\theta}[1+\mu(1-\tilde{\varepsilon}l)]H_1$. The actual level of $\tilde{\varepsilon}$ is solved from (10b), after substituting both K_1 and $\overline{K}_1$ with $\frac{\beta(1+\theta)}{1+\beta\theta}[1+\mu(1-\tilde{\varepsilon}l)]H_1$.

Discussion:

- Smaller leverage and larger adjustment costs imply a higher threshold of volatility associated with liquidation [see (12)]. In the no-liquidation range $(\varepsilon > \tilde{\varepsilon})$, (13) implies that investment drops by half of the anticipated liquidity shock. This drop is financing an equal increase in ex-ante hoarding of international reserves. This hoarding will mitigate the effects of adverse liquidity shocks in bad times. The adverse liquidity shock would induce a real depreciation of $\frac{\varepsilon\beta l\mu H_1}{Z}$ (see 14). The extra liquidity induced by hoarding reserves, and the real deprecation in bad times allow the economy to adjust fully without the need to liquidate tangible capital. Yet, this comes at the cost of a drop in planned investment and output.

- If $\tilde{\varepsilon} < 1$, we have a mixed regime: for large enough volatility above the threshold, the regime is characterized by a partial liquidation of capital in bad times. For volatility below the threshold, the liquidation option would not be exercised. Hence, high enough volatility induces a regime switch from the non liquidation to the partial liquidation of capital.

An example of the two regimes is provided in Figure 2, tracing the optimal planned investment K_1 as a function of volatility. Recalling that $R_1 = (1+\mu)H_1 - K_1$, the patterns of reserves as a function of volatility, are the mirror image of the patterns of the planned investment: $dR_1 / d\varepsilon = -dK_1 / d\varepsilon$. Panel A (B) corresponds to a relatively high (low) adjustment cost, θ = 0.2 (θ = 0.02). For relatively low volatility, liquidation would not be exercised, and higher volatility would reduce the planned investment, increasing the level of reserves. These reserves will be used to meet adverse liquidity shocks, saving the need to engage in a costly ex-post liquidation of productive investment. High enough volatility implies that the liquidation option would supplement the defensive hoarding of reserves. Note that liquidation mitigates the adverse impact of higher volatility on the planned investment, as can be seen by comparing the slopes of the two lines below and above the volatility threshold, $\tilde{\varepsilon}$. This mitigation, however, comes at a deadweight loss associated with adjustment costs.

Interestingly, at the regime switch to the partial liquidation regime, we observe a discrete drop of the planned investment, and a matching discrete jump in the ex-ante hoarding of reserves. This follows from the observation that the switch to the partial liquidation regime *increases* the marginal valuation of liquid reserves. The intuition for this is straightforward – in the partial liquidation regime, an extra unit of liquid reserves saves the need to liquidate $1+\theta$ capital, saving the deadweight loss of θ. This marginal benefit of liquidity is absent in the 'no liquidation' regime. Consequently, at the regime switch, there is discontinuity where the ex-ante demand for liquidity jumps, inducing a drop in planned investment. This drop increases with the adjustment costs, as is vividly illustrated by the contrast between the two panels of Figure 1. This point can be confirmed by comparing (11) and (13a) at the threshold volatility associated with regime change. Denoting the no liquidation (liquidation) regime by NL (LQ), respectively, it can be verified that at $\varepsilon = \tilde{\varepsilon}$

$$(15) \qquad K_{1|NL} - \bar{K}_{1|LQ} = \theta^2 \frac{\beta(1-\beta)}{(1+\theta)(1-\beta\theta)}(1+\mu)H_1$$

A key variable is the adjustment cost parameter, θ, measuring the flexibility of capital market adjustment. Greater flexibility of the adjustment reduces the role of

international reserves, and of the overall impact of volatility on investment and on the real exchange rate.

Hoarding reserves mitigates the volatility of the real exchange rate and of the adverse effects of liquidity shocks on the GDP. To fully appreciate this observation, it's useful to evaluate the expected output in the absence of the precautionary adjustment of international reserves. Using the parameters specified in Figure 2a, the planned capital is $K_1 = 1$. The actual capital in the presence of liquidity shock and the absence of the IR precautionary adjustment would have been $\overline{K_1} = 1 - \mu\varepsilon lH_1(1+\theta)$. The solid line in Figure 3 plots the expected output in this regime as a fraction of the output had the liquidity shock been zero. The bold line is the expected normalized output for the case where reserves are adjusted to prevent the need to liquidate capital, as is the case in equation (13). The figure vividly illustrates the first order gain associated with the precautionary adjustment of international reserves. It is easy to verify that the precautionary adjustment of reserves also reduces the volatility and the REER.

The present model is not detailed enough to identify who would hold the international reserves – private banks, or the central bank. In the presence of capital controls, like in China, the international reserves would be held by the central bank. With full integration of capital markets and convertibility and an efficient market for excess reserves that allows diversifying idiosyncratic shocks, the bulk of the international reserves may be held by private banks. However, moral hazard considerations along the line analyzed by Levy Yeyati (2005), or in the absence of an efficient market for excessive reserves, international reserves would be held by the central bank.

The model we described is stylistic – we do not derive the collateral constraint endogenously, and we do not claim that the debt contract or the resolution of the liquidity shock is the most efficient one. Taking the debt contract exogenously given, we characterize the resultant role of international reserves.[9] See Ranciere, Tornell and

[9] We also do not model the mechanism inducing capital flight in the presence of adverse terms of trade shocks. This may reflect both contagion and the possibility of multiple equilibrium, or fundamental forces. For further discussion on "fundamentals based Crisis" see Allen and Gale (1998) and Goldfajn and Valdes (1997); for panic based see Chang and Velasco (1999).

Westermann (2003) for a discussion on the dynamic interaction between an unconstrained traded sector and a constrained non-traded sector in the presence of liquidity pressure.

The model suggests that adverse liquidity shocks triggered by terms of trade deterioration are accommodated by higher reserves and real depreciation, adjustments that limit the needed liquidation of capital. While our framework dealt with one investment cycle, it can be extended into a dynamic set up, where the next cycle resembles a similar sequence, subject to updating the entrepreneurs' initial wealth by the profits of the previous investment cycle and by any outside income. In the extended setup, terms of trade improvements (deterioration) would tend to lead to a further real exchange rate appreciation (depredation). This would be the case in circumstances where the entrepreneurs' outside income includes proceeds from the exported commodity, implying that higher wealth would increase the future demand for non-traded input. Alternatively, this would be the case if the non traded input has other uses, the demand of which rises with the wealth of the economy.

3. International reserves management and mercantilist motives

The discussion in the previous section viewed international reserve management in the context of reducing the costs of economic volatility, reflecting the desire for self-insurance against exposure to future sudden stops. This view faces a well-known contender in a modern incarnation of mercantilism: international reserves accumulation triggered by concerns about export competitiveness. This explanation has been advanced by Dooley, Folkerts-Landau and Garber (2003), especially in the context of China. This issue is of more than academic importance: the precautionary approach links reserves accumulation directly to exposure to sudden stops, capital flight and volatility, whereas the mercantilist approach views reserves accumulation as a residual of an industrial policy, a policy that may impose negative externalities on other trading partners. Dooley, Folkerts-Landau and Garber have interpreted reserves accumulation as a by-product of promoting exports, which are needed to create better jobs, thereby absorbing abundant labor in traditional sectors, mostly in agriculture. Under this strategy, reserves accumulation may facilitate export growth by preventing or slowing appreciation –

> "we argued that a sensible development policy might involve creating a distortion in the real exchange rate in order to bias domestic investment toward export industries. Sensible here means that the resulting capital stock will be superior to that generated by a badly distorted domestic financial system and other relative price distortions typical of emerging market countries." [Dooley, Folkerts-Landau and Garber (2005)].

To put this discussion in a boarder context, the mercantilist explanation for hoarding international reserves presumes that a monetary policy affecting the level of the exchange rate has permanent real effects. While the view that monetary instability has long run adverse real consequences is well supported by empirical studies, there is no comparable body of evidence that validates the long run real impact of setting the level of the nominal exchange rate. Indeed, anecdotal evidence suggests that the neo-classical adjustment mechanism works "even" in China – economic growth leads to real appreciation independently of the exchange rate regime.

The growing importance of foreign direct investment, and the observation that a large hoarding of international reserves has occasionally occurred in countries experiencing a large foreign direct investment inflow, put to the fore an extended version of the "Revived Bretton Woods system," where international reserves are viewed as a collateral reducing the risk associated with FDI:

> "Delivering goods and services up front is a crude form of collateral. But there is no credible alternative. Market participants individually could pledge financial assets in the center country, but the only way that the aggregate of the periphery can acquire assets in the US is to run a current account surplus. In an important sense, the goods and services already delivered to the US support the stock of US claims on the periphery; it is the collateral that powers the entire development strategy.
> The nature of the social collateral is so obvious it is hard to see. If the center cannot seize goods or assets after a default, it has to import the goods and services before the default and create a net liability. If the periphery then defaults on its half of the implicit contract, the center can simply default on its gross liability and keep the collateral. The periphery's current account surplus provides the collateral to support the financial intermediation that is at the heart of Asian development strategies. The interest paid on the net position is nothing more than the usual risk free interest paid on collateral." [Dooley, Folkerts-Landau and Garber (2005)].

The wide reaching implications of Dooley, Folkerts-Landau and Garber (2005) has propagated spirited debate that goes well beyond the scope of our paper.[10] Some view the modern mercantilist approach as a valid interpretation for most East Asian countries, arguing that they follow similar development strategies. This interpretation is intellectually intriguing, yet it remains debatable. Observers have pointed out that high export growth is not the new kid on the block -- it is the story of East- Asia during the last fifty years. Yet, the large increase in hoarding reserves has happened mostly after 1997. Indeed, one may argue that the experience of Japan and Korea suggests that during the phase of their rapid growth, the policy tool of choice was selective favorable financing targeted sectors, and not hoarding international reserves.[11] In both countries large hoarding of international reserves happened after the end of the high growth phase.

Aizenman and Lee (2005) test the importance of precautionary and mercantilist motives in accounting for the hoarding of international reserves by developing countries. While variables associated with the mercantilist motive (like lagged export growth and deviation from Purchasing Power Parity) are statistically significant, their economic importance in accounting for reserve hoarding is close to zero and is dwarfed by other variables. Overall, the empirical results in Aizenman and Lee (2005) are in line with the precautionary demand. The effects of financial crises have been localized, increasing reserve hoarding in the aftermath of crises mostly in countries located in the affected region, but not in other regions. A more liberal capital account regime is found to increase the amount of international reserves, in line with the precautionary view. These results, however, do not imply that the hoarding of reserves by countries is optimal or efficient. Making inferences regarding efficiency would require having a detailed model and much more information, including an assessment of the probability and output costs of sudden stops, and the opportunity cost of reserves.

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[10] See Caballero, Farhi and Gourinchas (2006), Eichengreen (2006a), and the overview in Glick and Spiegel (2005).

[11] Interestingly, during the period of rapid growth, both Korea and Japan were closed to FDI. Hence, the view that FDI is the key for successful development in East Asia remains debatable.

Aizenman and Lee (2006) proposes a new interpretation of the association between mercantilism, economic growth and hoarding reserves by looking at the development strategies of East Asian countries during the second half of the 20th Century. The history of the region suggests the prevalence of export promotion by preferential financing, which effectively subsidized investment in targeted sectors. This was achieved in several ways, including direct subsidies funded by state banks; or by means of financial repression where favored sectors enjoyed preferential access to cheaper external borrowing; or via "moral suasion" where private banks were encouraged to provide favorable financing. We refer to this policy as *financial mercantilism*, and contrast it with *monetary mercantilism*, a policy that hinges on hoarding international reserves.

The history of Japan and Korea suggests the (near) absence of monetary mercantilism during the phase of fast growth. Evidence suggests that financial mercantilism had been vigorously applied during the phase of rapid growth. In both countries, the switch to large hoarding of international reserves happened at times of collapsing growth. Thus, if monetary mercantilism played any significant role in these countries, it was adopted in periods of disappointing growth. The legacy of financial mercantilism led to deteriorating balance sheets of affected banks. Circumstances where floundering growth leads to the switch from financial mercantilism to large hoarding of reserves are associated with growing fragility of the banking system -- financial fragility is more sustainable in times of rapid growth, but it may induce banking crises when growth flounders.[12] In these situations, precautionary motives may lead countries to hoard international reserves in order to mitigate the possible transmission of banking crisis to currency crisis. With limited data, such a response may be observationally equivalent to the one predicted by monetary mercantilism. Having good data about international reserves but spotty data on non performing loans, it is hard to disentangle

[12] The research triggered by Kaminsky and Reinhart (1999) points out that greater financial fragility increases the odds of currency crisis. Hutchison & Noy (2005) report that "… the onsets of 31% of banking crises were accompanied by currency turmoil. Furthermore, there is a statistically significant correlation between lagged banking crises and contemporaneous currency crises but not vice versa." This observation is consistent with the insight of models of financial fragility, exemplified by Chang and Velasco (1999).

the precautionary hoarding from the monetary mercantilism. Moreover, monetary mercantilism and precautionary hoarding may be mutually complementary: the competitiveness benefit may reduce the effective cost of hoarding reserves and induce governments to prefer reserve-hoarding over alternative precautionary means.

China's hoarding of reserves picked up sharply after the Asian crisis. Unlike Korea and Japan, China is accumulating reserves without having gone through a sharp slow-down in economic growth. We conjecture that the recent history of Japan and Korea provided evidence encouraging China to adopt a dual strategy of financial mercantilism and rapid hoarding of international reserves. Arguably, as much as China is growing even faster than Korea and Japan in their early years and is going through its take-off process in the era of a highly integrated global financial market, China faces much greater downside risk of social and political instability associated with a crisis than the risk that confronted Korea or Japan. This greater downside risk of recession and financial crisis may explain both the Chinese eagerness to push financial mercantilism, and to buffer the downside risk of the growing financial fragility with aggressive reserve hoarding.[13] Given the sheer size of China and its reserve hoarding, however, other countries in the region may be tempted to engage in competitive hoarding in order to mitigate the competitiveness loss in third markets.

Furthermore, monetary mercantilism is associated with negative externalities akin to competitive devaluation. Hoarding international reserves motivated by short-run competitiveness concerns of one country may trigger other countries into adopting a similar policy, to preempt any competitive advantage gained by the first country. These circumstances may lead to competitive hoarding of reserves, which in turn would dissipate any competitiveness gains. We provide a simple framework illustrating the welfare losses associated with competitive hoarding. These losses may provide a novel argument in favor of regional funds, viewed as a mechanism to cope with regional

[13] In the case of China, the ratio of banks' non performing loans/international reserves is estimated to be in the range of about 20% (according to the Bank of China) to more than 90% (see Jim Peterson's report at the *International Herald Tribune*, 9-11-2006). These numbers indicate a large uncertainty associated with estimating the economy-wide burden of financial weakness, which itself would add to the demand for precautionary hoarding.

negative externalities. The greater importance of manufacturing in East Asia relative to Latin America, and the deeper financial repression in some East Asian countries suggests that the case for Asian fund is stronger than that for a similar regional fund among Latin American countries.[14]

4. Current account persistence and international reserves

The purpose of this section is to ascertain the degree to which higher international reserves/GDP ratios have been associated with greater capacity to smooth adjustment to shocks overtime, allowing more persistent current account patterns. In contrast, a low level of reserves may require a rigid and fast adjustment of the current account to shocks, where deviations from a balanced current account position are hard to sustain. We evaluate this possibility by applying the methodology of Taylor (2002), where the speed of adjustment of the current account (CU) back towards its equilibrium or steady state level, was captured by the value of β in the regression[15]

$$\Delta\left(\frac{CU}{GDP}\right)_t = \beta\left(\frac{CU}{GDP}\right)_{t-1} + \varepsilon_t \ . \tag{16}$$

Noting the AR reinterpretation of (16), $\left(\frac{CU}{GDP}\right)_t \cong (1+\beta)\left(\frac{CU}{GDP}\right)_{t-1} + \varepsilon_t$, β close to minus one implies no persistence of the current account pattern, as would be the case if the adjustment to a shock is contemporaneous. In contrast, $|\beta|$ closer to zero implies greater persistence of the current account, allowing a more protracted adjustment to shocks.

We start by fitting the following regression:

$$\Delta\left(\frac{CU}{GDP}\right)_{it} = CountryEffects_i + TimeEffects_t + \beta_{sample}\left(\frac{CU}{GDP}\right)_{it-1} + e_{it} \ , \tag{17}$$

[14] The presumption is that the real exchange rate has greater consequences on the competitiveness of manufacturing exporters than on countries specializing in exporting commodities and raw materials [for further discussion on regional funds see Eichengreen (2006b)].

[15] See Taylor (2002) for a discussion linking the above estimation to intertemporal long run budget constraints.

where $\left(\frac{CU}{GDP}\right) = Ln(1+\left(\frac{CurrentAccount}{DomesticGDP}\right))$, and both the current account balance and the domestic economy GDP are measured in current US$. Table 4 shows the coefficient of adjustment and thus a measure of persistence for the current account balance for 1970-2004, subject to data availability, and subsets of the data such as Developing countries, Developed OECD countries, Manufacture exporters, Natural Resource Exporters, Latin American and Asian emerging economies. Table 4 also reviews sub samples based on 1980-1992 and 1993-2004, Indebtedness and Income as classifications given by the World Bank. Note that developing countries are characterized by a faster current account adjustment than the OECD, LATAM adjust faster than Asian emerging economies, and exporter of natural resource countries adjust faster than the exporters of manufacturing.

Cross-section study of the factors affecting the persistence of the current account balance

We turn now to a cross country study testing the impact of international reserves on the speed of adjustment. On average, we expect that a higher build up of reserves allows countries to be better buffered against shocks, thereby reducing the speed of adjustment of the current account, resulting in a positive association between international reserves and β. We apply a two step derivation of the relationship between reserves (and other government assets) and current account persistence. In the first step we derive a measure of current account persistence.

We ran a time series regression for each available country in the form of:

$$\Delta\left(\frac{CU}{GDP}\right)_t = \beta\left(\frac{CU}{GDP}\right)_{t-1} + \varepsilon_t \quad (18)$$

This way we obtain one β coefficient per country. The countries, the number of observations used in the autoregressive estimation of their β and the fitted values are listed in Tables B1-B4, in Appendix B. Table 5 provides the estimates for several LATAM countries.

The persistence proxy used in the next step is just the value for the pure autoregressive process of the current account deflated by GDP:

$$(19) \qquad \left(\frac{CU}{GDP}\right)_t = \alpha\left(\frac{CU}{GDP}\right)_{t-1} + \varepsilon_t \text{ where } \alpha = \beta + 1.$$

In the second step we look at the cross section relationship between our measure of persistence represented by α and a series of structural parameters for these economies, and a measure of the stock of reserves deflated by the GDP. [16]

In the univariate regressions, we find that higher reserves, higher GDP growth and a lower share of commodities are associated with a significant increase in the persistency of the current account for non OECD countries [see Table 6]. International reserves turned out insignificant for a sample inclusive of the OECD countries. In the multivariate regressions we find that for developing countries higher persistence is positively associated with a higher IR/GDP, lower inflation, greater flexibility of the exchange rate [measured by the volatility of the nominal exchange rate], and a higher share of manufacturing [see Table 7].

The results reported above are consistent with the consumption smoothing role of current account adjustments. To illustrate, consider a benchmark neo-classical economy where consumption is determined the permanent income hypothesis (linear marginal utility of consumption); the output follows an AR(1) process $Y_t - \bar{Y} = \rho(Y_{t-1} - \bar{Y}) + \bar{Y}\varepsilon_t$ ($|\rho| < 1$, output reverting to the long run mean $\bar{Y}$ at a rate determined by 1 - ρ); and where agents can borrow and lend at the real interest *r*, which also equals their subjective rate of time preference. It can be shown that, around the long run equilibrium,[17]

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[16] Out of 134 countries, there are 10 countries with negative alphas that would represent extreme volatility in the current account. These countries are generally small economies with very sensitive external sectors. In order to reduce noise in future regressions we purge these countries from the data. See the countries in Italics, Table B4, Appendix B.

[17] This follows the observation that in such an economy, $C_t = rB_t + \bar{Y} + \frac{r}{1+r-\rho}\left\{Y_t - \bar{Y}\right\}$.

Hence, $CU_t = rB_t + Y_t - C_t = \frac{1-\rho}{1+r-\rho}\left\{Y_t - \bar{Y}\right\}$. Hence, in the vicinity of the long run equilibrium,

$$(20) \qquad \left(\frac{CU}{Y}\right)_t \simeq \rho\left(\frac{CU}{Y}\right)_{t-1} + \frac{1-\rho}{1+r-\rho}\varepsilon_t .$$

Hence, $\alpha \simeq \rho$. Suppose that we modify the above assumptions, adding the possibility of sudden stops. Specifically, assume that the probability of a sudden stop, terminating the ability to borrow externally, is Φ; where $\Phi = \Phi(IR/Y);\ \Phi' < 0$. In these circumstances,

$$(21) \qquad \alpha \simeq \rho(1-\Phi) .$$

This suggests that a negative association between sudden stops and hoarding reserves may account for the impact of international reserves on the persistency of current account adjustment.

5. On the limitations of international reserves management

We close the paper with a discussion of the limitations of international reserves management. While useful, IRM is not a panacea, and is subject to serious limitations outlined below.

- Moral hazard: as with any insurance, there is no way to avoid various layers of moral hazard.

  - Macro moral hazard: any deep pot of resources may be the target of opportunistic raiding by policy makers in regimes characterized by political instability and limited monitoring. Central bank independence helps and is desirable, but not sufficient to overcome this obstacle [see Aizenman and Marion (2004) for empirical results on the adverse effects of political instability on hoarding international reserves].

$$\frac{CU_t}{Y_t} = \frac{1-\rho}{1+r-\rho}\frac{\rho(Y_{t-1}-\bar{Y})+\bar{Y}\varepsilon_t}{Y_t} = \rho\frac{CU_{t-1}}{Y_{t-1}}\frac{Y_{t-1}}{Y_t} + \frac{1-\rho}{1+r-\rho}\frac{\bar{Y}}{Y_t}\varepsilon_t \simeq \rho\frac{CU_{t-1}}{Y_{t-1}} + \frac{1-\rho}{1+r-\rho}\varepsilon_t .$$

- Micro moral hazard: large stockpiles of reserves may subsidize risk taking, especially if it is viewed as a signal of a low probability of exchange rate changes [see Levy Yeyati (2005), advocating a combined scheme of decentralized reserves in the form of liquid asset requirements on individual banks to limit moral hazard, and an ex-ante suspension-of-convertibility clause to reduce self-insurance costs while limiting bank losses in the event of a run].

- Fiscal costs: these costs include a direct opportunity cost (the marginal product of investment or the cost of external borrowing), and any marginal costs of sterilization [see Calvo (1991) for an early discussion on the quasi costs of sterilization]. Hauner (2005) estimated these costs for 100 countries during 1990–2004, concluding that while most countries made money on their reserves during 1990–2001, most have been losing money during 2002–04. One should keep in mind, however, the difficulties in tracing the full benefits of hoarding reserves:

> "While assessing the fiscal cost of holding reserves, it would be worthwhile to set off the benefits that the country may have in holding reserves. In any country risk analysis by the rating agencies and other institutions, the level of reserves generally has high weights. Moreover, it is essential to keep in view some hidden benefits which could accrue to a country holding reserves, which may, inter alia, include: maintaining confidence in monetary and exchange rate policies; enhancing the capacity to intervene in foreign exchange markets; limiting external vulnerability so as to absorb shocks during times of crisis; providing confidence to the markets that external obligations can always be met; and reducing volatility in foreign exchange markets. It is true that beyond a point, when the credit rating reaches appropriate investment grade, addition to reserves may not lead to further improvement in the credit rating. It is necessary to recognize that, as in the case of costs, there are difficulties in computing the benefits too."
>
> *Dr. YV Reddy, Governor, Reserve Bank of India / Mumbai Sep 20, 2006*

- Coordination issues: while our focus was on IRM as self insurance, IRM management may be part of a fiscal scheme dealing with augmenting social security and future pensions. This is especially relevant for countries exporting commodities, like Chile, Norway, etc. This suggests the need to delegate the management of these funds to two different agencies. One, like the central bank, should deal with IRM as part of prudent macroeconomoic management

throughout the business cycle. The second fund fits more the treasury, or the social security administration, as it deals with long term intergenerational transfer. For further discussion, see Davis et. al. (2001).

To conclude, this paper outlined several motives for hoarding international reserves in the era of growing financial integration. The message of the report is mixed –management of reserves is not a panacea. The mercantilist case for hoarding international reserves, as an ingredient of an export led growth strategy, is dubious. Done properly, international reserve management reduces the downside risk in turbulent times. These benefits are especially important for commodity exporting countries; and countries with limited financial development.

Appendix A

Financial Transmission of Terms of Trade Shocks in Natural Resource Economies – The case of Chile

Meta Data and Definitions

-The frequency of the data is quarterly
-Sources: IFS, DataStream, CEIC, WEO, ICRG
-Gap Variables are obtained by detrending the variables. The trend is calculated using the Hodrick/Prescott filter with lambda set to 1600 (recommended value for quarterly data).
-Log differences are use as proxy for percentage growth

Monetary Aggregates:

-**MB** equals Monetary Base

-**M1** equals currency in circulation plus demand deposits in checking accounts of the nonfinancial private sector net of float, demand deposits other than those in checking accounts and demand savings deposits.

-**M2** encompasses M1 plus time deposits of the private sector, plus time saving deposits, plus mutual funds (FM) quotas in up to one-year instruments (non financial private sector) and plus deposits of Saving and Credit Cooperatives (CAC), less FM investments in M2 and less CAC investments in M2.

-**M3** corresponds to M2 plus foreign exchange deposits of the private sector, plus instruments of the Central Bank, plus Treasury bonds, plus credit bills, plus other Mutual Funds (FM) quotas, plus AFP voluntary saving quotas, less FM investments in M3 and less AFP investments in M3.
-**Private Credit:** We define private credit as M3-M1
-**Reserves**: Comprise special drawing rights, reserves of IMF members held by IMF, and holdings of foreign exchange under the control of monetary authorities

Interest Rates:

-**Deposit Rates**: rates offered to resident customers for demand, time, or savings deposits.
-**Lending Rates**: bank rate that usually meets the short- and medium-term financing needs of the private sector. This rate is normally differentiated according to creditworthiness of borrowers and objectives of financing.
-**Domestic Spread (DS)**: We define the Domestic Spread (DS) as the difference between the Lending Rate and the Deposit Rate.

Terms of Trade: As usual, TOT is calculated as the ratio of export to import price indexes.

Real Output:

-Real Aggregate Demand

-Real GDP

External Perception of Country Specific Risks:

-Economic Risk: A means of assessing a country's current economic strengths and weaknesses. In general, where strengths outweigh weaknesses, a country will show low risk and where weaknesses outweigh strengths, the economic risk will be high. To ensure comparability between countries, risk components are based on accepted ratios between the measured data within the national economic/financial structure, and then the ratios are compared, not the data. Risk points are assessed for each of the component factors of GDP per head of population, real annual GDP growth, annual inflation rate, budget balance as a percentage of GDP, and current account balance as a percentage of GDP. Risk ratings range from a high of 50 (least risk) to a low of 0 (highest risk), though lowest de facto ratings are generally near 15.

-Financial Risk Rating: A means of assessing a country's ability to pay its way by financing its official, commercial and trade debt obligations. To ensure comparability between countries, risk components are based on accepted ratios between the measured data within the national economic/financial structure, and then the ratios are compared, not the data. Risk points are assessed for each of the component factors of foreign debt as a percentage of GDP, foreign debt service as a percentage of exports of goods and services (XGS), current account as a percentage of XGS, net liquidity as months of import cover, and exchange rate stability. Risk ratings range from a high of 50 (least risk) to a low of 0 (highest risk), though lowest de facto ratings are generally near 20.

Econometric Analysis

Single OLS Equation: Effects of TOT into Financial Variables

The OLS indicates that an improvement in the TOT is associated with:

- A drop of the financial spread = [lending rates - deposit rates]
- Improvement in Chile’s financial and economic risk assessment.
- A positive gap between both the Real Output and the Real Demand and their long run trend.
- Higher growth rate of M1.
- Lower growth rate of private credit (M3-M1).

	REAL GDP	REAL DEMAND	MB	M1	M2	M3	RESERVES	DOMESTIC SPREAD	DEPOSIT RATE	LENDING RATE	ECON RISK	FINANCIAL RISK	PRIVATE CREDIT
TOT	0.012	0.042***	0.012	0.09	-0.041	-0.167	-0.054	-15.732**	-22.39	-24.001	0.258	0.353**	-0.256**
	[0.056]	[0.014]	[0.133]	[0.127]	[0.086]	[0.104]	[0.223]	[7.802]	[26.380]	[28.146]	[0.166]	[0.171]	[0.121]
TOT L1	0.06	0.034**	0.054	0.255*	0.016	-0.141	0.024	-17.945**	-13.047	-16.99	0.258	0.197	-0.396***
	[0.075]	[0.013]	[0.129]	[0.141]	[0.085]	[0.108]	[0.254]	[7.331]	[23.559]	[25.365]	[0.189]	[0.179]	[0.118]
TOT L2	0.135	0.015	0.094	0.268*	0.086	-0.095	0.041	-16.473**	7.781	7.639	0.124	0.041	-0.363***
	[0.081]	[0.012]	[0.134]	[0.157]	[0.091]	[0.117]	[0.287]	[7.477]	[27.996]	[29.899]	[0.194]	[0.146]	[0.115]
TOT L3	0.151*	0.001	0.173	-0.137	0.123	0.038	-0.209	-0.523	45.655	52.223	0.055	-0.191	0.175
	[0.082]	[0.015]	[0.140]	[0.190]	[0.098]	[0.142]	[0.303]	[10.676]	[46.595]	[47.505]	[0.219]	[0.203]	[0.179]
TOT L4	0.196**	0.003	0.183	0.123	0.144	-0.016	-0.037	-9.387	33.737	38.591	0.013	-0.081	-0.138
	[0.077]	[0.012]	[0.150]	[0.192]	[0.096]	[0.130]	[0.299]	[9.490]	[39.113]	[41.211]	[0.227]	[0.164]	[0.170]
Observations	80	81	81	81	81	81	81	81	81	81	81	81	81

Table A1: Single OLS Equation; Effects of TOT into Financial Variables
TOT, MB, M1, M2, M3, Econ Risk, and Financial Risk variables are represented in log differences proxy for the growth rates.
Real GDP and Real Demand represent the deviations from their long run trend.
TOT, MB, M1, M2, M3, Reserves, Econ Risk, and Financial Risk

Vector Autorregression (VAR) Analysis

$\Pi_t = A + \sum_{i=0} B_i \Pi_{t-i} + E$ Where Π_t = {Real Demand Gap, Lending Rate, Deposit Rate International Risk (proxy for foreign spread), Money Supply (M1), Domestic Credit (M3-M1), TOT}

	REAL DEMAND GAP	Lending Rate	Deposit Rate	M1	PRIVATE CREDIT	ECON RISK	TOT
TOT(-1)	2.206**	-0.775**	-0.761**	0.37*	-0.386*	0.76**	1.39***
	-1.005	-0.359	-0.375	-0.213	-0.215	-0.336	-0.09
TOT(-2)	-3.7***	0.106	0.083	0.131	-0.091	-0.487	-0.819***
	-1.126	-0.402	-0.42	-0.239	-0.24	-0.377	-0.101
C	-0.112*	0.003	0.016	-0.011	0.005	-0.014	0.009
	0.061	0.022	0.023	0.013	0.013	0.021	0.005
R-squared	0.966	0.816	0.845	0.454	0.377	0.29	0.858
Adj. R-squared	0.958	0.776	0.811	0.334	0.241	0.134	0.828
Sum sq. resids	1.085	0.138	0.151	0.049	0.049	0.121	0.009
S.E. equation	0.13	0.046	0.049	0.028	0.028	0.044	0.012
F-statistic	129.526	20.304	24.984	3.797	2.772	1.864	27.73
Log likelihood	57.273	138.707	135.245	179.779	179.279	143.795	248.153
AIC	-1.07	-3.132	-3.044	-4.172	-4.159	-3.261	-5.903
Schwarz SC	-0.62	-2.682	-2.594	-3.722	-3.709	-2.811	-5.453

Table A2: VAR analysis on the effects of terms of trade shocks

Table 2 Reports the effects of terms of trade shocks (measured as changes in the TOT growth rates) on the different key macro variables of the Chilean economy given by a second order vector autoregressive equation (the remaining coefficients are not reported here).

We chose two lags for our VAR following the Schwarz and the Hannan-Quinn criterions

Lag	LogL	LR	FPE	AIC	SC	HQ
0	911.528	0	5.70E-20	-24.447	-24.229	-24.36
1	1176.146	472.022	1.69E-22	-30.274	-28.531	-29.579
2	1293.722	187.486	2.74E-23	-32.128	-28.858*	-30.823*
3	1342.764	68.924	2.99E-23	-32.129	-27.334	-30.216
4	1421.307	95.525*	1.61E-23	-32.927	-26.607	-30.406
5	1482.338	62.681	1.60E-23	-33.252	-25.406	-30.122
6	1556.53	62.161	1.38e-23*	-33.933	-24.561	-30.195
7	1634.354	50.48	1.52E-23	-34.712*	-23.815	-30.365

Table A3: VAR lag order selection criteria

The VAR analysis shows properties similar to the ones uncovered by the OLS approach; a positive shock to the growth rate of TOT is associated with:

- A drop in the same order of magnitude of both the lending and the deposit rate. The negative impact is slightly bigger in the lending rate which may help explain the negative coefficient of the domestic spread in the single OLS equation.
- Improvement in Chile's external risk evaluation.
- Higher growth rate of M1, and lower growth rate of private credit (M3-M1).
- Higher real aggregate demand. The initial positive effect is then quickly reversed after the first lag.

Table A4 reports the variance decomposition of the previous VAR. The analysis shows that changes in the growth rate of TOT absorb a significant variance from variables like the real aggregate demand, deposits and lending rates, money supply growth and private credit. For this decomposition we assume TOT to be the most exogenous measure so we place this variable last in the Cholesky order.

Variance Decomposition of Real Demand:

Period	Real Demand	Deposit	Lending	M1	Priv Credit	Econ Risk	TOT
1	100						
2	97.35	0.3	1.12	0.01	0.05	0.39	0.78
3	95.63	0.17	2.28	0.3	0.03	0.43	1.16
4	93.73	0.15	3.98	0.83	0.03	0.46	0.83
5	90.81	0.2	5.88	1.45	0.08	0.57	1.01
6	86	0.23	7.86	1.91	0.31	0.7	2.99
7	79.93	0.21	9.63	2.06	0.78	0.81	6.59
8	74.23	0.37	11.05	1.96	1.41	0.87	10.11
9	70.06	0.94	12.1	1.87	1.95	0.92	12.16
10	67.46	1.88	12.78	1.98	2.22	0.99	12.67

Variance Decomposition of Deposit Rates:

1	4.95	95.05					
2	4.65	88.99	1.05	0.73	1.56	0.32	2.71
3	4.62	81.44	1.53	1.02	3.6	0.57	7.21
4	4.52	76.36	1.45	2.64	4.57	0.48	9.98
5	4.81	72.4	2.57	3.46	5.12	0.44	11.2
6	5.37	69.96	4.08	3.9	5.8	0.4	10.49
7	5.86	67.68	5.71	4.2	6.59	0.4	9.56
8	6.05	65.27	7.32	4.4	7.72	0.46	8.77
9	5.95	63.1	8.56	4.71	8.96	0.55	8.18
10	5.71	61.14	9.51	5.12	10.1	0.62	7.8

Variance Decomposition of Lending Rates:

1	5.09	91.93	2.98				
2	4.59	87.58	2.49	0.79	1.77	0.54	2.23
3	4.51	79.18	3.73	0.89	3.92	1.2	6.57
4	4.47	74.26	3.58	2.32	5.25	1.04	9.09
5	4.87	69.93	4.83	3.22	5.89	0.96	10.28
6	5.66	67.01	6.48	3.72	6.62	0.88	9.63
7	6.43	64.41	8.17	4.09	7.37	0.84	8.7
8	6.86	61.76	9.83	4.34	8.41	0.88	7.92
9	6.91	59.46	11.13	4.68	9.54	0.94	7.34
10	6.7	57.46	12.14	5.13	10.59	1.01	6.98

Variance Decomposition of M1:

1	9.8	48.04	1.27	40.88			
2	8.38	41.49	3.98	39.24	0.13	4.96	1.82
3	7.42	37.18	3.49	37.09	0.18	8.67	5.96
4	7.41	35.8	4.13	35.5	0.36	8.3	8.49
5	7.3	35.64	4.06	33.96	1.54	8.26	9.23
6	7.2	35.21	4.01	33.74	2.48	8.26	9.1
7	7.12	34.57	3.95	33.63	3.06	8.12	9.55
8	7.04	33.99	3.89	33.54	3.18	7.98	10.38
9	6.96	33.81	3.93	33.42	3.19	7.9	10.79
10	6.97	34	4.1	33.18	3.2	7.83	10.72

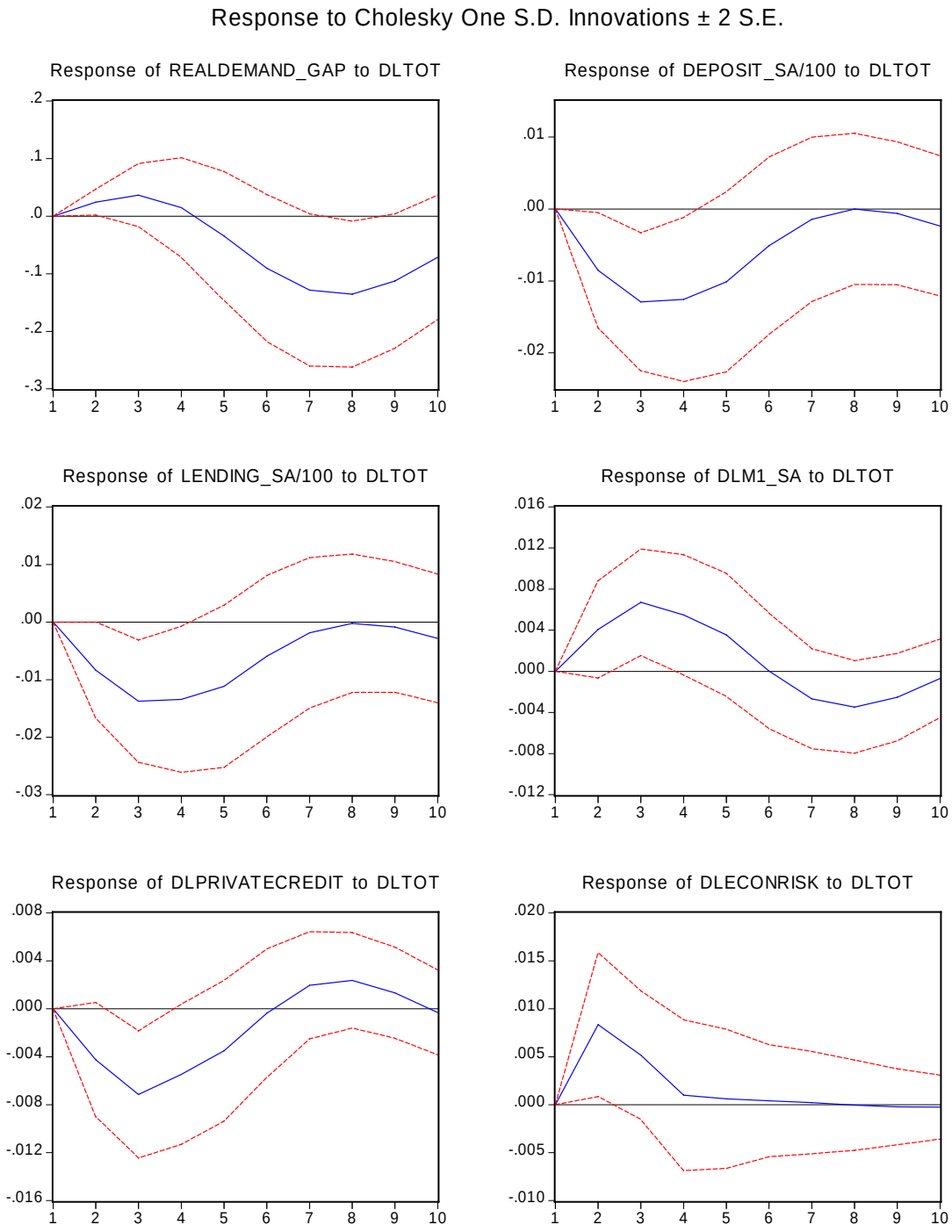
Variance Decomposition of Private Credit:

1	9.4	56.17	1.62	24.23	8.58		
2	8.67	53.24	3.19	21.11	9.28	2.53	1.99
3	7.75	47.48	3.11	19.09	9.23	6.53	6.8
4	7.42	45.79	2.98	19.08	9.21	6.24	9.29
5	7.26	44.71	3.05	19.38	8.99	6.42	10.19
6	7.4	44.49	3.65	19.17	8.86	6.38	10.05
7	7.6	44.4	4.12	18.76	8.69	6.25	10.18
8	7.63	44.01	4.54	18.41	8.75	6.18	10.47
9	7.56	43.72	4.76	18.22	9.05	6.19	10.51
10	7.55	43.46	4.84	18.18	9.33	6.2	10.45

Variance Decomposition of Econ risk:

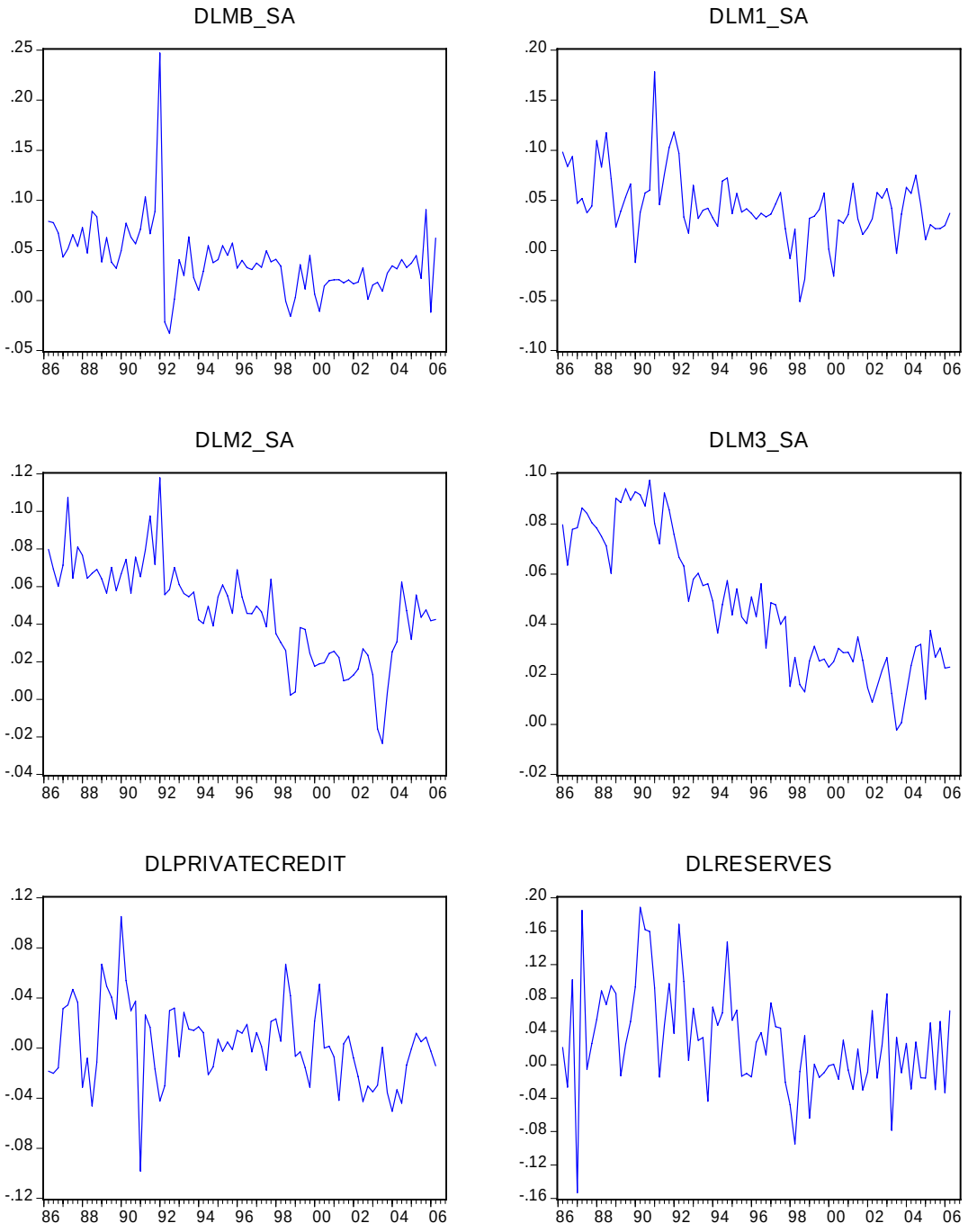
1	0.43	0.86	2.38	5.76	0.87	89.7	
2	0.46	1.39	2.2	6.02	3.8	82.74	3.39
3	0.84	4.47	2.01	10.12	3.62	75.13	3.82
4	0.91	5.32	2.08	10.34	3.65	73.93	3.78
5	0.91	5.48	2.07	10.32	3.68	73.76	3.78
6	0.91	5.48	2.07	10.34	3.74	73.68	3.78
7	0.93	5.48	2.07	10.39	3.8	73.56	3.78
8	0.95	5.48	2.07	10.44	3.84	73.45	3.77
9	0.99	5.5	2.08	10.45	3.86	73.35	3.77
10	1.02	5.52	2.11	10.47	3.88	73.25	3.76

Table A4: VAR variance decomposition

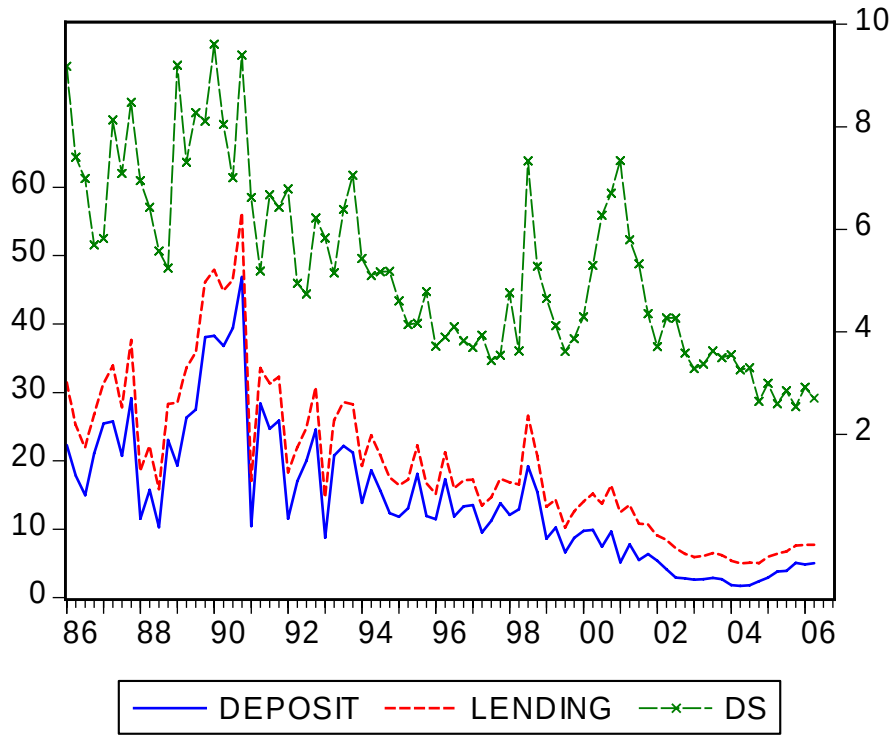


Graph A1: Impulse Responses to one Standard Deviation innovation in the TOT growth rates

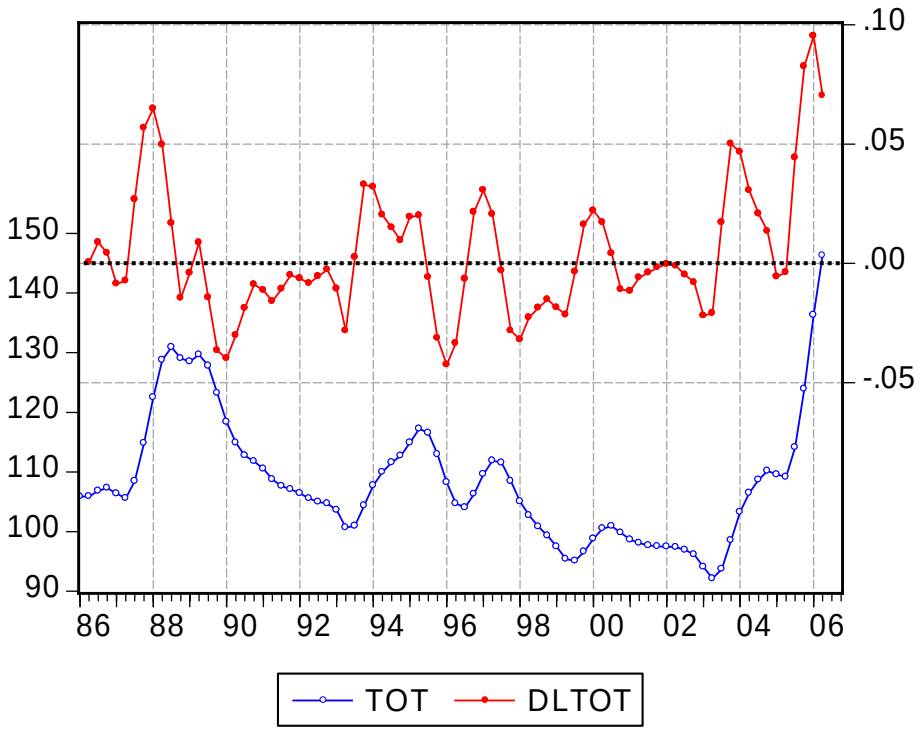
Graphical Appendix



Graph A2: Growth rates of the monetary Aggregates

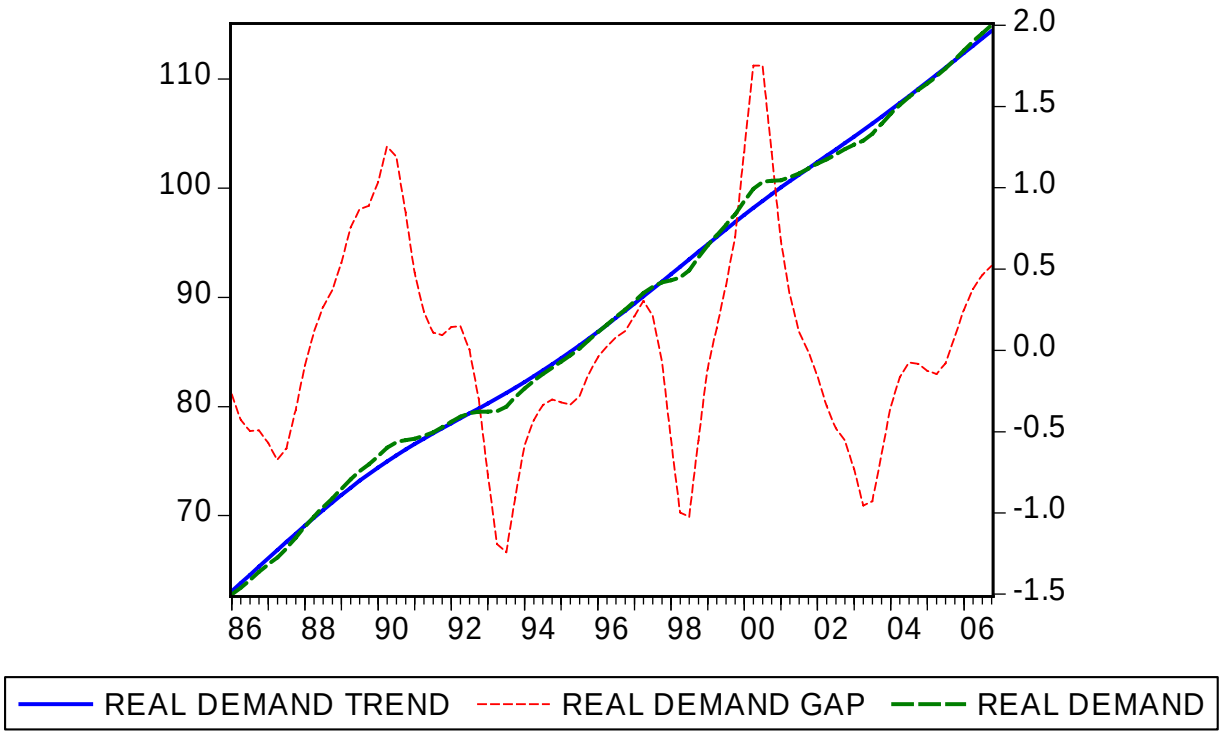


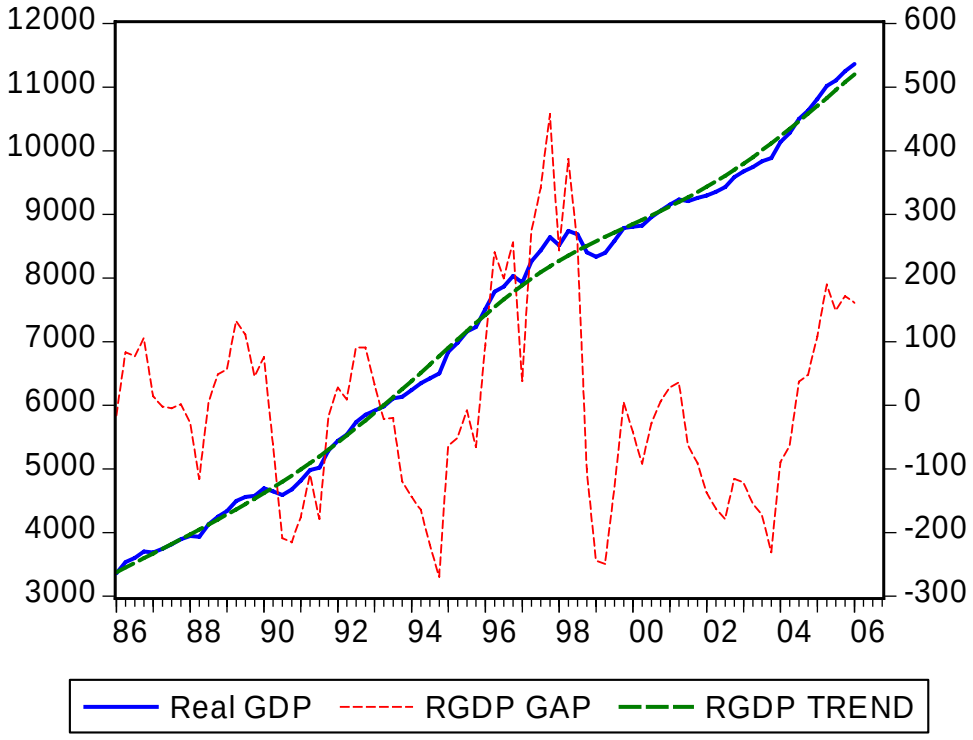
Graph A3: Interests rates and domestic spread



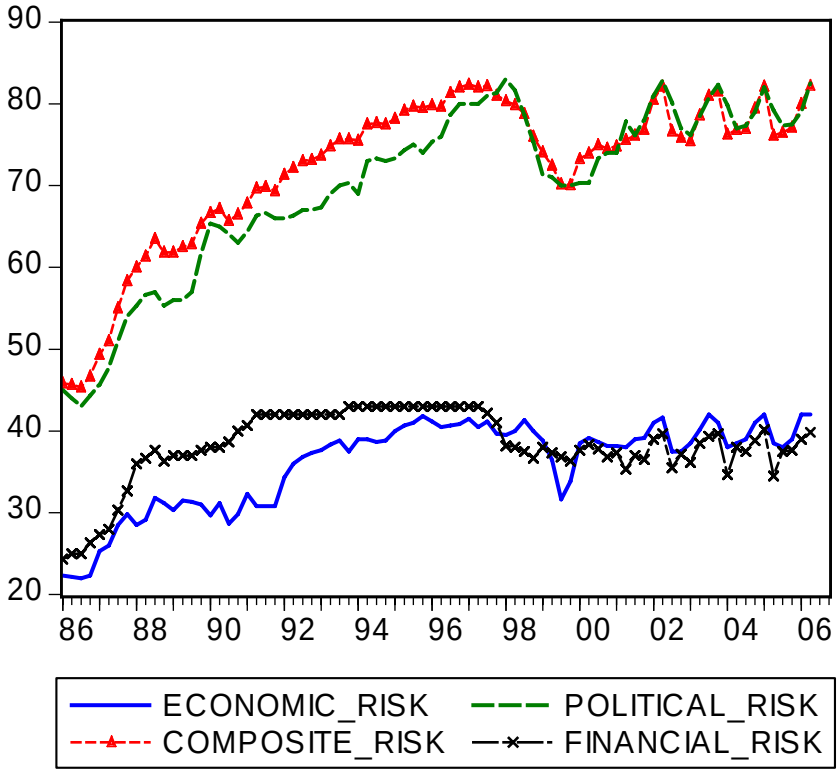
Left scale is the index number for TOT (Export Price Index/ Import Price Index. Seasonally adjusted); right scale is the Growth rate of TOT (proxied by DLTOT).

Graph A4: Terms of Trade





Graph A5: Real Aggregate Demand and Real Aggregate Output



Graph A6: External Measures of Country Risk

Appendix B: Data definitions and tables

"Manufactures":
Average of annual observations of the percentage of economic activity dedicated to the production of manufactures (measured as percentage of the GDP), following the definition given by the United Nations, Manufactures comprises pf the tabulation category D and divisions 15-37 in the International Standard Industrial Classification of All Economic Activities, Revision 3. It is defined as the physical or chemical transformation of materials or components into new products, whether the work is performed by power-driven machines or by hand, whether it is done in a factory or in the worker's home, and whether the products are sold as wholesale or retail. Included are assembly of component parts of manufactured products and recycling of waste materials.

"Commodities":
Average of annual observations of the percentage of economic activity dedicated to the production of agricultural products, mining, hunting, and utilities.

"Reserves":
Average of annual observations of the Stock of Reserves over GDP taken during the sample period. The sample period depends on data availability.

"NE Volatility":
Nominal exchange rate volatility is the average annual volatility. Each annual observation corresponds to the percent standard deviation of the monthly nominal rate of the domestic currency against the U.S. dollar, $\sqrt{\sum\left(\frac{x-\bar{x}}{\bar{x}}\right)^2 \Big/ (n-1)}$) .

"Financial Integration":

Average of annual observations of Edward's measure of financial integration (see Capital Mobility and Economic Performance: Are Emerging Countries Different?)

"Inflation"

Average of annual CPI inflation observations

"Terms of Trade":

Average of annual observations of the terms of trade defined as the ratio of the export price index to the corresponding import price index, measured relative to the base year 2000.

Table B1: Indebtedness Ranking

1 = Severely Indebted	2 = Moderately Indebted	3 = Less Indebted
Angola	Benin	Albania
Argentina	Bolivia	Algeria
Belize	Burkina Faso	Armenia
Brazil	Cambodia	Azerbaijan
Bulgaria	Cameroon	Bangladesh
Burundi	Cape Verde	Barbados
Central African Rep.	Chile	Belarus
Chad	Colombia	Bosnia & Herzegovina
Comoros	El Salvador	Botswana
Congo, Republic of	Ethiopia	China
Côte d'Ivoire	Honduras	Costa Rica
Croatia	Hungary	Czech Republic
Dominica	Jamaica	Djibouti
Ecuador	Kenya	Dominican Republic
Eritrea	Lithuania	Egypt
Estonia	Madagascar	Equatorial Guinea
Gabon	Malaysia	Fiji
Gambia, The	Mauritania	Georgia
Grenada	Mauritius	Ghana
Guinea	Moldova	Guatemala
Guinea-Bissau	Mongolia	Haiti
Guyana	Niger	India
Indonesia	Nigeria	Iran, I.R. of
Jordan	Pakistan	Lesotho
Kazakhstan	Papua New Guinea	Macedonia, FYR
Kyrgyz Republic	Paraguay	Maldives
Lao People's Dem.Rep	Philippines	Mali
Latvia	Poland	Mexico
Liberia	Russia	Morocco
Malawi	Slovak Republic	Mozambique
Myanmar	Solomon Islands	Namibia
Panama	Sri Lanka	Nicaragua
Peru	St. Lucia	Oman
Rwanda	St. Vincent & Grens.	Romania
Samoa	Tunisia	Senegal
São Tomé & Príncipe	Turkmenistan	South Africa
Seychelles	Uganda	Swaziland
Sierra Leone	Venezuela, Rep. Bol.	Tanzania
Somalia		Thailand
St. Kitts and Nevis		Tonga
Sudan		Trinidad and Tobago
Syrian Arab Republic		Ukraine
Tajikistan		Vanuatu
Togo		Vietnam
Turkey		Yemen, Republic of
Uruguay		
Zambia		

Table B2: Income Level

1=Low Income	2=Lower-Middle Income	3=Upper-Middle Income	4=High Income
Afghanistan, I.S. of	Albania	Antigua and Barbuda	Aruba
Bangladesh	Algeria	Argentina	Australia
Benin	Angola	Barbados	Austria
Burkina Faso	Armenia	Belize	Bahamas, The
Burundi	Azerbaijan	Botswana	Bahrain, Kingdom of
Cambodia	Belarus	Chile	Belgium
Cameroon	Bolivia	Costa Rica	Canada
Central African Rep.	Bosnia & Herzegovina	Croatia	Hong Kong
Chad	Brazil	Czech Republic	Macao
Comoros	Bulgaria	Dominica	Cyprus
Congo, Republic of	Cape Verde	Equatorial Guinea	Denmark
Côte d'Ivoire	China	Estonia	Faroe Islands
Eritrea	Colombia	Gabon	Finland
Ethiopia	Djibouti	Grenada	France
Gambia, The	Dominican Republic	Hungary	Germany
Ghana	Ecuador	Latvia	Iceland
Guinea	Egypt	Libya	Ireland
Guinea-Bissau	El Salvador	Lithuania	Israel
Haiti	Fiji	Malaysia	Italy
India	Georgia	Mauritius	Japan
Kenya	Guatemala	Mexico	Kuwait
Korea	Guyana	Oman	Luxembourg
Kyrgyz Republic	Honduras	Panama	Malta
Lao People's Dem.Rep	Indonesia	Poland	Netherlands
Lesotho	Iran, I.R. of	Russia	Netherlands Antilles
Liberia	Iraq	Seychelles	New Zealand
Madagascar	Jamaica	Slovak Republic	Norway
Malawi	Jordan	South Africa	Portugal
Mali	Kazakhstan	St. Kitts and Nevis	Saudi Arabia
Mauritania	Macedonia, FYR	St. Lucia	Singapore
Moldova	Maldives	St. Vincent & Grens.	Slovenia
Mongolia	Morocco	Trinidad and Tobago	Spain
Mozambique	Namibia	Turkey	Sweden
Myanmar	Paraguay	Uruguay	Switzerland
Nepal	Peru	Venezuela, Rep. Bol.	United Kingdom
Nicaragua	Philippines		United States
Niger	Romania		
Nigeria	Samoa		
Pakistan	Sri Lanka		
Papua New Guinea	Suriname		
Rwanda	Swaziland		
São Tomé & Príncipe	Syrian Arab Republic		
Senegal	Thailand		
Sierra Leone	Tonga		
Solomon Islands	Tunisia		
Somalia	Turkmenistan		
Sudan	Ukraine		
Tajikistan	Vanuatu		
Tanzania	West Bank and Gaza		
Togo			
Uganda			
Vietnam			
Yemen, Republic of			
Zambia			

Table B3: Data Availability for each country

country	start	end	country	start	end	country	start	end
Afghanistan, I.S. of	1979	1981	Gambia, The	1978	1997	Nigeria	1977	2004
Albania	1984	2003	Georgia	1997	2004	Norway	1970	2004
Algeria	1970	1997	Germany	1971	2004	Oman	1974	2003
Angola	1985	2004	Ghana	1975	2004	Pakistan	1970	2004
Antigua and Barbuda	1977	2002	Grenada	1977	2002	Panama	1977	2004
Argentina	1970	2004	Guatemala	1970	2004	Papua New Guinea	1976	2001
Armenia	1993	2004	Guinea	1986	2004	Paraguay	1970	2004
Aruba	1991	2002	Guinea-Bissau	1982	1997	Peru	1970	2004
Australia	1970	2004	Guinea-Bissau	2001	2003	Philippines	1970	2004
Austria	1970	2004	Guyana	1977	1985	Poland	1985	2004
Bahamas, The	1976	2003	Guyana	1992	2004	Portugal	1972	2004
Bahrain, Kingdom of	1980	2003	Haiti	1971	2003	Romania	1987	2004
Bangladesh	1976	2004	Honduras	1974	2004	Russia	1994	2004
Barbados	1970	2003	Hungary	1982	2004	Rwanda	1976	2004
Belarus	1993	2004	Iceland	1970	2004	Samoa	1978	1999
Belgium	2002	2004	India	1970	2003	São Tomé & Príncipe	1974	1990
Belize	1984	2004	Indonesia	1970	2004	São Tomé & Príncipe	1998	2002
Benin	1974	2003	Iran, I.R. of	1976	1990	Saudi Arabia	1970	2004
Bolivia	1970	2004	Iran, I.R. of	1993	2000	Senegal	1974	2003
Bosnia & Herzegovina	1998	2004	Iraq	1976	1977	Seychelles	1976	2004
Botswana	1975	2003	Ireland	1970	2004	Sierra Leone	1977	2004
Brazil	1970	2004	Israel	1970	2004	Singapore	1970	2004
Bulgaria	1980	2004	Italy	1970	2004	Slovak Republic	1993	2000
Burkina Faso	1974	1994	Jamaica	1970	2004	Slovak Republic	2002	2003
Burkina Faso	2000	2001	Japan	1970	2004	Slovenia	1992	2004
Burundi	1985	2003	Jordan	1970	2004	Solomon Islands	1975	1999
Cambodia	1992	2004	Kazakhstan	1995	2004	Somalia	1977	1989
Cameroon	1977	1995	Kenya	1975	2004	South Africa	1970	2004
Canada	1970	2004	Korea	1970	2004	Spain	1970	2004
Cape Verde	1986	2003	Kuwait	1975	2003	Sri Lanka	1970	2004
Central African Rep.	1977	1994	Kyrgyz Republic	1993	2004	St. Kitts and Nevis	1980	2002
Chad	1977	1994	Lao People's Dem.Rep	1984	2001	St. Lucia	1979	2002
Chile	1970	2004	Latvia	1992	2004	St. Vincent & Grens.	1978	2002
China	1982	2004	Lesotho	1975	2004	Sudan	1977	2004
Hong Kong	1998	2004	Liberia	1979	1987	Suriname	1977	2004
Macao	2002	2002	Libya	1977	1987	Swaziland	1974	2004
Colombia	1970	2004	Libya	1990	2004	Sweden	1970	2004
Comoros	1980	1995	Lithuania	1993	2004	Switzerland	1970	2004
Congo, Republic of	1978	2003	Luxembourg	1995	2004	Syrian Arab Republic	1970	2004
Costa Rica	1970	2004	Macedonia, FYR	1996	2004	Tajikistan	2002	2004
Côte d'Ivoire	1970	2004	Madagascar	1974	2003	Tanzania	1988	2004
Croatia	1993	2004	Malawi	1977	2002	Thailand	1970	2004
Cyprus	1976	2004	Malaysia	1970	2003	Togo	1974	2003
Czech Republic	1993	2004	Maldives	1980	2004	Tonga	1975	1993
Denmark	1970	2004	Mali	1975	2003	Tonga	2001	2002
Djibouti	1992	1995	Malta	1971	2004	Trinidad and Tobago	1970	2003
Dominica	1977	2002	Mauritania	1975	1998	Tunisia	1970	2004
Dominican Republic	1970	2004	Mauritius	1980	2004	Turkey	1970	2004
Ecuador	1970	2004	Mexico	1970	2004	Turkmenistan	1996	1997
Egypt	1970	2004	Moldova	1994	2004	Uganda	1980	2004
El Salvador	1970	2004	Mongolia	1993	2004	Ukraine	1994	2004
Equatorial Guinea	1987	1996	Morocco	1970	2004	United Kingdom	1970	2004
Eritrea	1992	2000	Mozambique	1980	2004	United States	1970	2004
Estonia	1992	2004	Namibia	1990	2004	Uruguay	1970	2004
Ethiopia	1981	2004	Nepal	1976	2004	Vanuatu	1982	2003
Euro Area	1998	2004	Netherlands	1970	2004	Venezuela, Rep. Bol.	1970	2004
Fiji	1979	1999	Netherlands Antilles	1980	1985	Vietnam	1996	2002
Finland	1970	2004	New Zealand	1970	2004	Yemen, Republic of	1990	2004
France	1970	2004	Nicaragua	1977	2004	Zambia	1978	1991
Gabon	1978	2003	Niger	1974	2003	Zambia	1997	2000

Table B4: Estimated β for each country*

Name	Beta	SE	Years	R-squared	Name	Beta	SE	Years	R-squared
Albania	-0.864	[0.170]***	19	0.4337	***Kazakhstan***	-1.036	[0.45]*	9	0.4668
Algeria	-0.499	[0.196]**	27	0.2159	**Kenya**	-0.597	[0.18]***	29	0.3039
Angola	-1.018	[0.192]***	19	0.5085	**Korea**	-0.336	[0.1]***	34	0.1715
Antigua and Barb.	-0.531	[0.169]***	25	0.2654	**Kuwait**	-0.859	[0.06]***	28	0.4328
Argentina	-0.396	[0.083]***	34	0.1896	**Kyrgyz Republic**	-0.669	[0.245]**	11	0.3358
Aruba	-1.216	[0.270]***	11	0.6406	**Lesotho**	-0.369	[0.159]**	29	0.1855
Australia	-0.333	[0.144]**	34	0.1534	**Liberia**	-0.71	[0.344]*	8	0.2223
Austria	-0.342	[0.196]*	34	0.1659	**Libya**	-0.764	[0.27]***	24	0.37
Bahamas, The	-0.422	[0.198]**	27	0.2768	***Luxembourg***	-1.235	[0.31]***	9	0.6728
Bahrain, Kingdom of	-0.543	[0.167]***	23	0.2777	***Macedonia, FYR***	-1.024	[0.426]*	8	0.4954
Bangladesh	-0.436	[0.144]***	28	0.2207	**Madagascar**	-0.397	[0.170]**	29	0.2189
Barbados	-0.236	[0.071]***	33	0.184	**Malawi**	-0.558	[0.19]***	25	0.2794
Benin	-0.87	[0.095]***	29	0.4344	**Malaysia**	-0.275	[0.115]**	33	0.114
Bolivia	-0.716	[0.234]***	34	0.3455	**Maldives**	-0.263	[0.117]**	24	0.2686
Botswana	-0.371	[0.158]**	28	0.1934	**Mali**	-0.684	[0.278]**	28	0.3379
Brazil	-0.214	[0.093]**	34	0.0841	**Malta**	-0.249	[0.106]**	33	0.1074
Bulgaria	-0.515	[0.189]**	24	0.2707	**Mauritius**	-0.514	[0.16]***	24	0.3008
Burkina Faso	-0.449	[0.228]*	21	0.2525	**Mexico**	-0.413	[0.15]***	34	0.2041
Burundi	-1.153	[0.215]***	18	0.5653	**Mongolia**	-0.512	[0.244]*	11	0.2986
Cambodia	-0.845	[0.141]***	12	0.4238	**Morocco**	-0.2	[0.115]*	34	0.0936
Cameroon	-0.837	[0.358]**	18	0.3319	**Mozambique**	-0.41	[0.151]**	24	0.2075
Canada	-0.194	[0.107]*	34	0.0816	**Nepal**	-0.312	[0.121]**	28	0.1609
Cape Verde	-0.25	[0.121]*	17	0.1713	**New Zealand**	-0.498	[0.14]***	34	0.2497
Central African Rep.	-1.015	[0.237]***	17	0.5007	**Niger**	-0.593	[0.19]***	29	0.3091
Chad	-0.52	[0.193]**	17	0.2594	**Nigeria**	-0.615	[0.16]***	27	0.2834
Chile	-0.447	[0.117]***	34	0.2108	**Norway**	-0.118	[0.090]	34	0.0428
China	-0.506	[0.152]***	22	0.2379	**Oman**	-0.676	[0.15]***	29	0.3454
Hong Kong	-0.506	[0.173]**	6	0.3946	**Pakistan**	-0.347	[0.145]**	34	0.1785
Colombia	-0.361	[0.136]**	34	0.1842	**Panama**	-0.4	[0.192]**	27	0.1984
Comoros	-0.604	[0.150]***	15	0.302	**Papua New Guinea**	-0.276	[0.122]**	25	0.1239
Congo, Republic of	-0.629	[0.137]***	25	0.3085	**Paraguay**	-0.334	[0.157]**	34	0.1621
Costa Rica	-0.329	[0.103]***	34	0.1602	**Peru**	-0.533	[0.19]***	34	0.2844
Côte d'Ivoire	-0.272	[0.117]**	34	0.1252	**Philippines**	-0.285	[0.123]**	34	0.1364
Croatia	-0.714	[0.298]**	11	0.4914	**Poland**	-0.717	[0.23]***	19	0.3541
Cyprus	-0.404	[0.124]***	28	0.2039	**Portugal**	-0.325	[0.09]***	32	0.1774
Czech Republic	-0.626	[0.184]***	11	0.4961	**Rwanda**	-0.887	[0.23]***	28	0.4664
Denmark	-0.142	[0.072]*	34	0.066	**Samoa**	-0.402	[0.212]*	21	0.2103
Dominica	-0.658	[0.308]**	25	0.3384	**Saudi Arabia**	-0.225	[0.101]**	34	0.1048
Dominican Republic	-0.477	[0.232]**	34	0.1703	**Seychelles**	-0.47	[0.14]***	28	0.23
Ecuador	-0.73	[0.185]***	34	0.3629	**Sierra Leone**	-0.619	[0.232]**	27	0.3095
El Salvador	-0.917	[0.196]***	34	0.47	**Slovenia**	-0.702	[0.12]***	12	0.5682
Eritrea	-0.42	[0.133]**	8	0.3374	**Solomon Islands**	-0.601	[0.20]***	24	0.3213
Ethiopia	-0.818	[0.225]***	23	0.3456	**Somalia**	-0.837	[0.20]***	12	0.456
Euro Area	-0.732	[0.263]**	6	0.3507	**South Africa**	-0.434	[0.165]**	34	0.2458
Fiji	-0.537	[0.145]***	20	0.2653	**Spain**	-0.247	[0.118]**	34	0.1023
France	-0.346	[0.132]**	34	0.1711	**Sri Lanka**	-0.47	[0.14]***	34	0.2363
Gabon	-0.435	[0.140]***	25	0.2133	**St. Kitts and Nevis**	-0.456	[0.167]**	22	0.209
Gambia, The	-0.331	[0.132]**	19	0.2128	**St. Lucia**	-0.43	[0.175]**	23	0.2742

Georgia	-1.051	[0.115]***	7	0.8795	**St. Vincent & Gren.**	-0.56	[0.14]***	24	0.3311
Ghana	-0.585	[0.165]***	29	0.3038	**Sudan**	-0.359	[0.129]**	27	0.1894
Grenada	-0.317	[0.160]*	25	0.1633	**Suriname**	-0.642	[0.16]***	27	0.3163
Guatemala	-0.627	[0.165]***	34	0.3334	**Swaziland**	-0.216	[0.083]**	30	0.1343
Guinea	-1.033	[0.280]***	18	0.5167	**Syria**	-0.527	[0.13]***	34	0.268
Guinea-Bissau	-0.125	[0.132]	17	0.034	**Thailand**	-0.198	[0.05]***	34	0.0907
Guyana	-0.297	[0.096]***	20	0.1822	**Togo**	-0.838	[0.20]***	29	0.6201
Haiti	-0.282	[0.126]**	32	0.153	***Tonga***	-1.004	[0.25]***	19	0.5141
Honduras	-0.586	[0.163]***	30	0.2968	**Trinidad & Tobago**	-0.382	[0.11]***	33	0.2019
Hungary	-0.385	[0.225]	22	0.1799	**Tunisia**	-0.407	[0.14]***	34	0.1996
Iceland	-0.722	[0.153]***	34	0.3515	**Turkey**	-0.764	[0.18]***	34	0.3605
India	-0.189	[0.108]*	33	0.0736	**Uganda**	-0.372	[0.194]*	24	0.1863
Indonesia	-0.358	[0.126]***	34	0.1789	**United Kingdom**	-0.237	[0.101]**	34	0.1315
Iran, I.R. of	-0.992	[0.214]***	21	0.5216	**United States**	-0.008	[0.070]	34	0.0004
Israel	-0.403	[0.165]**	34	0.2148	**Uruguay**	-0.494	[0.13]***	34	0.2462
Italy	-0.425	[0.171]**	34	0.2136	**Vanuatu**	-0.887	[0.14]***	21	0.4174
Jamaica	-0.507	[0.142]***	34	0.2612	**Venezuela**	-0.656	[0.13]***	34	0.3164
Japan	-0.222	[0.090]**	34	0.1013	**Vietnam**	-0.499	[0.218]*	6	0.409
Jordan	-0.586	[0.158]***	34	0.2926	**Zambia**	-0.926	[0.18]***	16	0.4478

* significant at 10%; ** significant at 5%; *** significant at 1%

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Figure 1
The time line

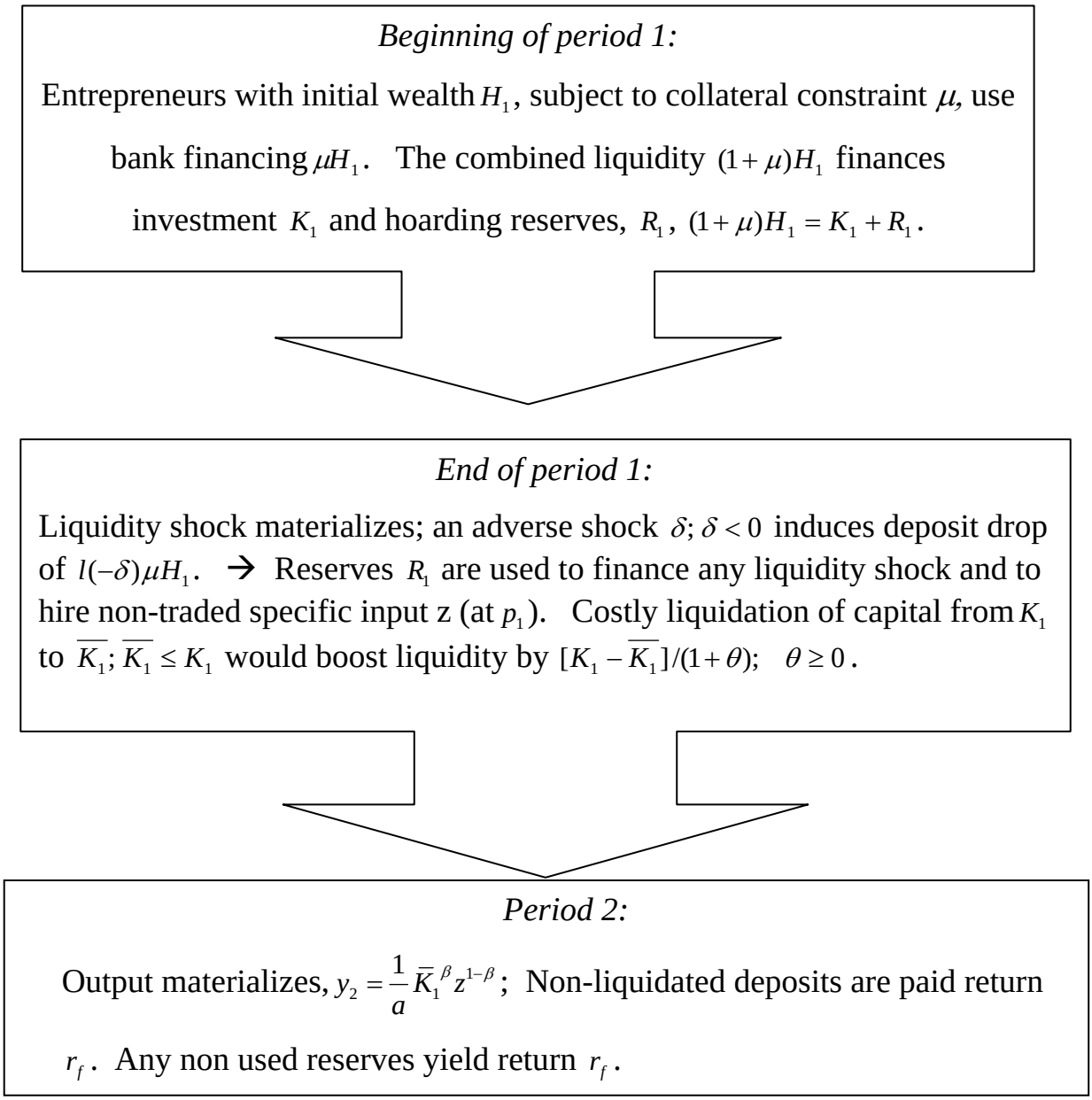
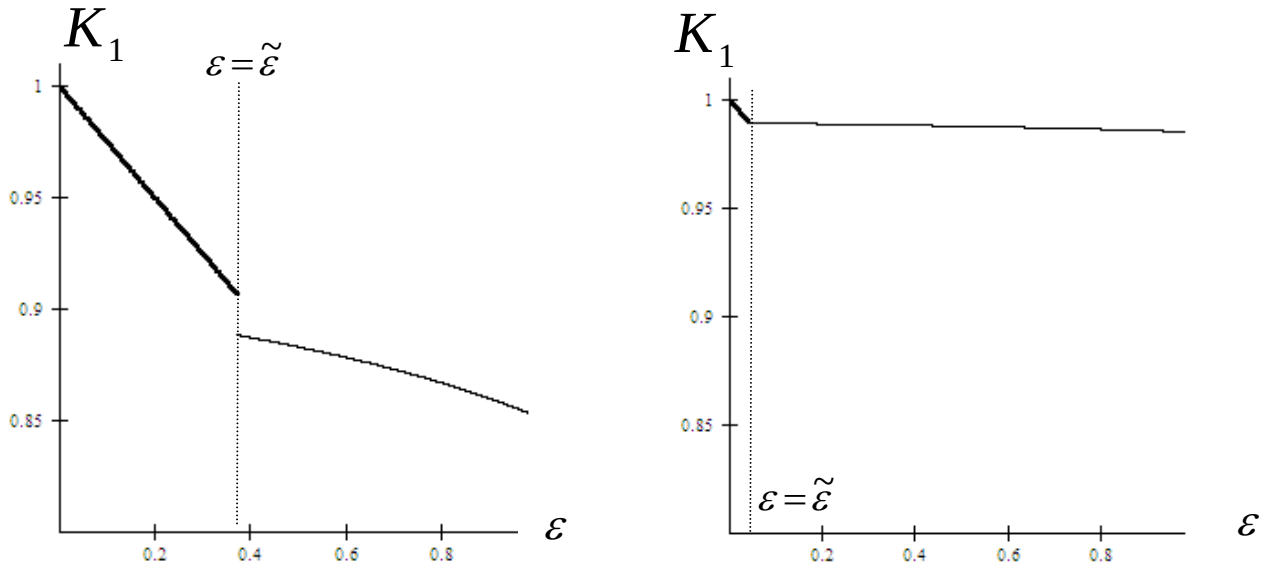


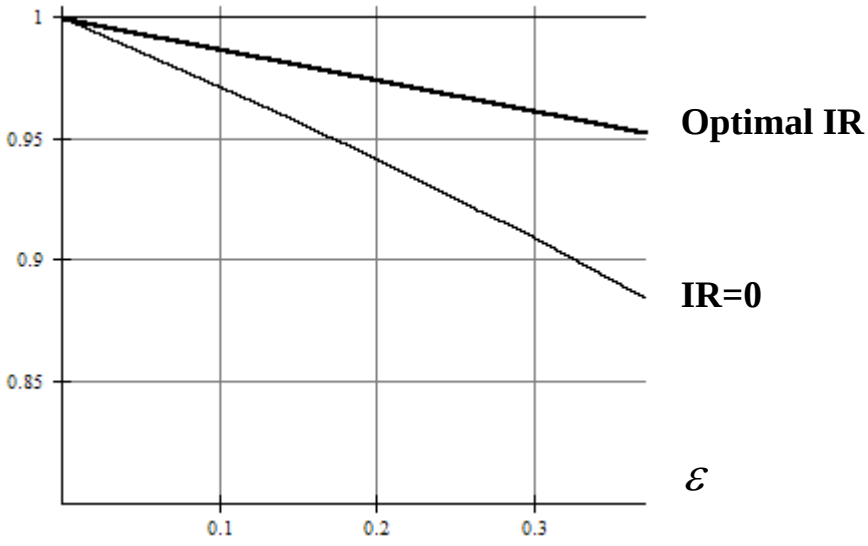
Figure 2
Volatility and planned investment



A. $\theta = 0.2$ B. $\theta = 0.02$

The simulation corresponds to the case where $\beta = 0.5; l = 1; H = 1; \mu = 1.$

Figure 3
Volatility and relative expected output



The simulation corresponds to the case where $\theta = 0.2$ $\beta = 0.5; l = 1; H = 1; \mu = 1.$ The bold curve corresponds to no liquidation and optimal precautionary demand for reserves, the solid curve corresponds to zero precautionary demand, where all the adjustment is made by liquidation.

Table 1: REER vs. Terms of Trade Shocks and Mitigation through Reserve Accumulation

Dependent Variable: Log REER	All	Developing	Industrial	Manufactures	Natural Resources	LATAM	ASIA
Log Terms of Trade shock	1.802***	1.836***	0.95	0.442	4.376***	1.642**	2.269**
	[0.244]	[0.255]	[0.594]	[2.077]	[0.779]	[0.802]	[1.104]
Log TOT*Reserves	-3.873***	-3.937***	-1.603	12.269	-10.676	-0.537	-4.672**
	[0.746]	[0.766]	[4.607]	[23.668]	[7.013]	[9.164]	[2.280]
Observations	1863	1260	603	271	253	343	202
R-Squared	0.4549	0.4367	0.5947	0.4066	0.6162	0.3903	0.2161
Years	1970-2004	1970-2004	1970-2004	1970-2004	1970-2004	1980-2004	1970-2004

Robust standard errors in brackets
* Significant at 10%; ** significant at 5%; *** significant at 1%

Table 2: REER vs. Lagged Terms of Trade Shocks and Mitigation through Reserve Accumulation

Dependent Variable: Log REER	All	Developing	Industrial	Manufactures	Natural Resources	LATAM	ASIA
Lagged Log TOT shock	1.773***	1.806***	0.784	0.23	4.362***	1.205	1.762
	[0.278]	[0.289]	[0.581]	[1.895]	[0.759]	[0.827]	[1.103]
Lagged Log TOT*RES	-3.557***	-3.633***	0.988	6.282	-11.528*	4.654	-4.024*
	[0.887]	[0.910]	[4.573]	[21.767]	[6.473]	[10.059]	[2.388]
Observations	1852	1263	589	262	252	343	201
R-Squared	0.4465	0.4302	0.5947	0.4027	0.6165	0.3898	0.2047
Years	1970-2004	1970-2004	1970-2004	1970-2004	1970-2004	1980-2004	1970-2004

Robust standard errors in brackets
* Significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Log REER vs. TERMS OF TRADE: Selective Individual Countries

Dependent Variable Log REER	Terms of Trade		Terms of Trade * Reserves		Obs	R-squared	Total Effect 1990-99	Total Effect 2000-04	Volatility of TOT
Argentina	44.994	[6.597]***	-793.738	[113.969]***	25	0.5594	-0.76438	-27.4739	0.0099
Chile	8.436	[1.561]***	-50.188	[13.080]***	23	0.6338	-1.46511	-0.97332	0.0517
Ecuador	7.158	[1.322]***	-46.25	[21.816]**	23	0.66	3.386239	5.400608	0.0573
Mexico	3.841	[2.048]*	-177.211	[71.729]**	23	0.1901	-5.69239	-9.71975	0.0360

Table 4: Current account Persistence across subgroups

	Dependent Variable D(CU/GDP)	Lag(CU/GDP)	SE	Obs.	R-squared
All Sample	All	-0.437***	[0.026]	4053	0.2548
1970-2004	Developing	-0.441***	[0.027]	3346	0.2608
	OECD	-0.260***	[0.036]	707	0.2315
	MA	-0.250***	[0.056]	273	0.3655
	NR	-0.362***	[0.049]	391	0.4182
	LATAM	-0.432***	[0.088]	594	0.3082
	ASIA	-0.217***	[0.063]	298	0.3812
1980-1992	All	-0.544***	[0.041]	1661	0.3316
	Developing	-0.546***	[0.042]	1394	0.3336
	OECD	-0.433***	[0.057]	267	0.2228
	LATAM	-0.523***	[0.091]	234	0.3395
	ASIA	-0.248***	[0.067]	114	0.1626
1993-2004	All	-0.563***	[0.046]	1708	0.3421
	Developing	-0.568***	[0.047]	1445	0.3443
	OECD	-0.347***	[0.059]	263	0.2224
	LATAM	-0.507***	[0.059]	216	0.3963
	ASIA	-0.315***	[0.087]	112	0.166
Indebtedness	DEBT1	-0.435***	[0.047]	1016	0.2737
	DEBT2	-0.512***	[0.040]	930	0.3515
	DEBT3	-0.412***	[0.057]	999	0.2449
Income Level	INCOME1	-0.413***	[0.044]	1137	0.2679
	INCOME2	-0.495***	[0.056]	1105	0.3302
	INCOME3	-0.496***	[0.057]	844	0.2809
	INCOME4	-0.315***	[0.050]	961	0.224

Table 5: Estimated β for selective countries*

Name	β	SE	Observations	R-squared
Argentina	-0.396	[0.083]***	34	0.1896
Brazil	-0.214	[0.093]**	34	0.0841
Chile	-0.447	[0.117]***	34	0.2108
Costa Rica	-0.329	[0.103]***	34	0.1602
Dominican Republic	-0.477	[0.232]**	34	0.1703
Ecuador	-0.73	[0.185]***	34	0.3629
El Salvador	-0.917	[0.196]***	34	0.47
Haiti	-0.282	[0.126]**	32	0.153
Honduras	-0.586	[0.163]***	30	0.2968
Mexico	-0.413	[0.149]***	34	0.2041
Uruguay	-0.494	[0.128]***	34	0.2462
Venezuela	-0.656	[0.129]***	34	0.3164

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Univariate Regressions

Dependent Variable :Alpha	ALL	Non OECD
RESERVES	0.068	0.183
	[0.110]	[0.100]*
NOMINAL EXCHANGE VOLATILITY	-0.056	0.058
	[0.247]	[0.240]
FINANCIAL INTEGRATION	0.142	-0.042
	[0.110]	[0.113]
TERMS OF TRADE	0.058	0.116
	[0.083]	[0.085]
GDP GROWTH	1.701	2.119
	[0.635]***	[0.639]***
% SHARE OF COMMODITIES	-0.415	-0.311
	[0.096]***	[0.102]***
INLFATION	-0.017	0.009
	[0.044]	[0.044]

Robust standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Multivariate Regression

Alpha	ALL	Non Oecd
Reserves	0.058	0.192
	[0.089]	[0.082]**
Inflation	-0.101	-0.072
	[0.042]**	[0.043]*
NE Volatility	0.566	0.545
	[0.303]*	[0.294]*
TOT	0.177	0.195
	[0.088]**	[0.098]*
Financial Int	0.298	0.076
	[0.114]**	[0.127]
Manufactures	0.784	0.628
	[0.212]***	[0.225]***
Observations	94	80
R-squared	0.2084	0.1618